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INTERNATIONAL

OCTOBER 1951

VOLUME 26 • NUMBER 10

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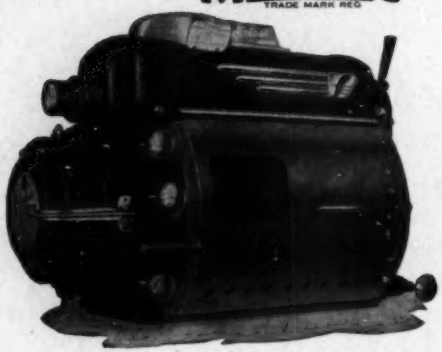

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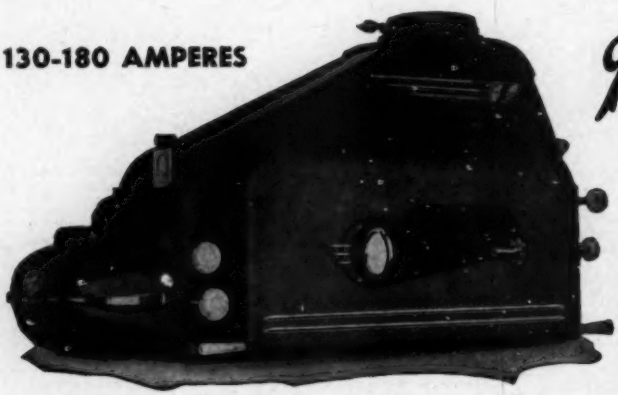

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HENRY B. SELLWOOD, *Editor*

Volume 26 OCTOBER 1951 *Number* 10

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Published Monthly by

INTERNATIONAL PROJECTIONIST PUBLISHING CO., INC.

19 West 44 Street, New York 18, N. Y.
Telephone: MUrray Hill 2-2948

R. A. ENTRACHT, Publisher

SUBSCRIPTION REPRESENTATIVES

AUSTRALIA: McGills, 183 Elizabeth St., Melbourne

NEW ZEALAND: Te Aro Book Depot, Ltd., 64 Courtenay Place, Wellington

ENGLAND and DOMINIONS: Wm. Dawson & Sons, Ltd., Macklin St., London, W. C. 2

YEARLY SUBSCRIPTION: United States and possessions, $2.50 (two years, $4); Canada and foreign countries, $3; single copies, 30 cents. Changes of address should be submitted two weeks in advance of publication date to insure receipt of current issue. Entered as second class matter February 8, 1932, at the Post Office at New York, N. Y., under the act of March 3, 1879.

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MONTHLY CHAT

THE most important development at the recent convention of the Theater Owners of America, to our mind, was not the gaudy equipment show nor the protracted discussions anent theater Tv but rather the report of a special TOA committee to the effect that careful investigation showed that equipment standards in more than 40% of motion picture theaters were definitely below par. And we take the word "par" to mean something less than acceptable.

This is a serious indictment of a group of showfolk who talk blithely of spending $15,000 and more for theater Tv equipment but will not invest a fraction of this sum for those units which will serve up a decent screen image. Incredible though it may seem to the majority of urban projectionists, the fact is that there still are hundreds — maybe 1500 — theaters which utilize low-intensity projection.

We're all for the lush carpeting and swellegant decor in a movie theater, but none of these factors contributes to the image on the screen. We're all for, too, the untiring efforts of lamp manufacturers to provide ever more and better light; but it seems a little silly to us to sound off about 15,000 lumens when there remain so many theaters with outmoded projection plants.

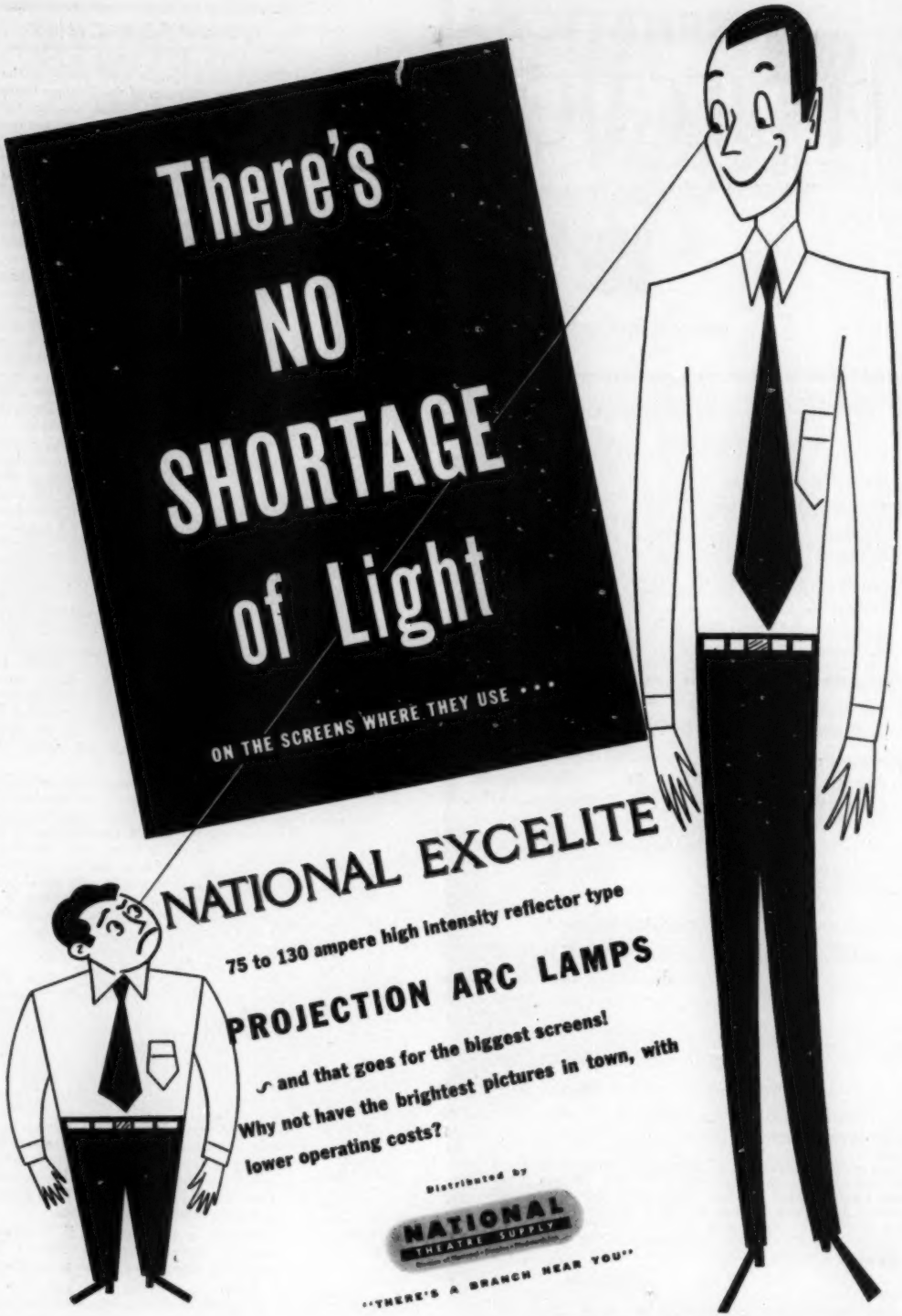
It's natural that the small exhibitor should seek to get by on an "as is" basis, particularly in view of a sagging box-office which only recently has begun to perk up. However, the extinction of hundreds of these small theaters will become a fact even sooner than is prophesied if an effort is not made to replace and repair that junk which today passes for projection equipment.

Some enterprising manufacturer might do himself a lot of good by directing a special campaign to these smaller theaters, not as a one-shot gesture but on a steady, methodical basis. And the first port of call should be the projectionist so that he and the supply man could put up a common front to Mr. Exhibitor. We have an idea that such a move would pay off.

* * *

It now appears certain that within six months there will be some 200 theaters equipped for Tv showings *via* either the direct-projection or intermediate-film systems. Looming large among the many problems posed by this development is that of projectionist competency. No amount of instruction by a field engineer will serve to give the projectionist the "feel" of an equipment: this can be had only by actual operating experience. If there is a theater Tv equipment in your area, drop around and spend as much time with it as you can. No instruction book can match such experience.

It would be a nice gesture if Tv manufacturers were to sponsor a series of Tv instruction clinics similar to those given by RCA.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VOLUME XXVI OCTOBER 1951 NUMBER 10

Is Lenticulated Color-Film Practical?

By ROBERT A. MITCHELL

THE proclivity of Hollywood brass to clamp restrictions on all technological progress in the motion picture field is paralleled only by the eagerness with which certain producers pursue any *fata morgana* flaunting the Lorelei promise of by-passing a few pennies of production.

The so-called lenticulated-film process of photographing and projecting movies in natural color is by no means of recent vintage. Eastman Kodak abandoned a variant of the process (known as "Kodacolor") in 1932 in favor of the totally different and immeasurably superior Kodachrome process for 16-mm filming.

Said Thomas E. Hargrave, president of Kodak:

"At least two American motion picture producers and a large European manufacturer have done a great deal of work in this [lenticular film] field over a considerable period of time. So far as we are aware, none of these efforts has yet met with commercial success."*

Industry Interest Revived

Readers of IP will recall that the lenticulated color-film process was described briefly and summarily dismissed on page 34, July 1951 issue of IP. But the recent settlement of the Keller-Dorian patent suit, in which Eastman and Technicolor were co-defendants, has refocused industry attention on the dejected color cadaver which certain production bigwigs are attempting to vivify—in the fond hope that the cost of color footage can be cut by a penny or fractional part thereof.

Should success attend this attempted vivification, however, Mr. Exhibitor would soon find himself hanging shirtless from a very high limb; while Mr. Producer pockets (he hopes) a trickle of pennies from inexpensive color-film processing. In our humble opinion, the exhibition industry would be best served by *improving* the movies, not by undermining the high degree of quality they already possess.

The theory of the lenticulated-film color process is indeed intriguing (from an academic point of view), and it works just fine and dandy on paper—providing that some mighty important factors are left out of account. So let's go over the whole thing once again with utter frankness, meanwhile offering a fervent prayer that lenticulated film will never be substituted for Technicolor.

Human Color Vision

As far as human color vision is concerned, the entire visible spectrum consists of only three overlapping bands of colors. Three primary colors, no more, no less. These are *Vermilion* (deep orange-red); *Emeraude* (slightly yellowish green); and *Indigo* (deep violet-blue). All other colors are merely combinations, in various proportions, of two or all three of these primaries.

The visual sensation called "white" is nothing more than the result of combining the three primaries in equivalent proportions. This may be demonstrated by a simple experiment.

If we cut strips from vermilion, emeraude, and indigo gelatine (called separation filters by photographers) and place one strip of each color over a camera lens so that no light can get through the lens without passing through the three filters placed side by side, it will be found that the performance of the lens is not seriously impaired as to image formation or its ability to image colored objects. Only the "speed" of the lens will have been impaired, since comparatively little light is transmitted by the filters.

Color-Filter Action

A distant white building focused upon a white card by the "color-filtered" lens furnishes ample proof that equivalent amounts of V, E, and I light form a white image when they recombine. A red object will give a red image, a yellow object a yellow image, *etc.*

All that happens is that the filters covering the lens split up the light into its V, E, and I components. The image-forming power of the lens recombines these three components into the original colored scene which is focused upon the card.

Another experiment shows what happens when one primary color is missing. Cover up the emeraude filter-strip, and the image of the white building will be colored *magenta*, which is the result of combining equivalent proportions of vermilion and indigo alone. With the vermilion strip covered up, the image will be *cyan*, which is emeraude plus indigo. And with the indigo strip masked off, the image of the white building will be *yellow*—vermilion plus emeraude.

Anatomy of Lenticular Film

Now, an ordinary black-and-white motion picture can be filmed through this "filtered" lens, but the lens diaphragm

* IP for December 1948, p. 35.

will have to be opened wide in order to admit sufficient light.

By using a *lenticulated* black-and-white film in the movie camera, however, a *natural-color* motion picture can be photographed through the lens which has one-third of its area covered by a vermilion filter, another third by an emeraude filter, and the last third by an indigo filter.

Lenticulated film is exactly the same photographically as ordinary black-and-white camera film. The only difference is the presence, on the lenticular film, of innumerable tiny semi-cylindrical ridges side by side. These are impressed in the film base on the side opposite the emulsion by means of embossing rollers. In the old 16-mm Kodacolor process, these corduroy-like lenticulations ran lengthwise on the film; and each had a width of 0.045-mm—about 559 ridges to the inch.

Each "ridge" on the lenticulated film functions as a tiny cylindrical lens.

Light Action Thru Lenticulations

To use the lenticular film, it must be threaded up in the camera with the lenticulated side of the film facing the lens. (In ordinary photography, the emulsion-side of the film faces the lens.) All of the light focused on the emulsion by the lens must accordingly pass through the tiny cylindrical lenses. The second precaution is to have the three colored gelatine strips on the lens parallel to the embossed lenticulations. In the case of Kodacolor, the filter strips were positioned vertically.

Each embossed lenticulation has a focal length of only 0.0045 mm. The lens-action of the tiny ridges causes the image to be split up into three "color bands" in the emulsion of the film, each band corresponding to one, and only one, of the three filter strips on the camera lens.

One color band contains a vermilion record of a very thin strip of the scene photographed; the second an emeraude record; and the third an indigo record. There is thus a partial image in each of the three primaries under each tiny lenticulation. The sum total of all the partial images on the film is the complete color record of the scene photographed.

The Projection Process

After reversal-development, the lenticular film looks like an ordinary black-and-white positive print. The lenticulations are too small and close together to be visible; and no actual color is present in the film.

To project the film in natural color it is only necessary to place *an exact replica* of the 3-strip camera-lens color filter over the projector lens. As in the camera, the gelatine filter strips must be parallel to the lenticulations of the film.

When the film is projected, light from all the vermilion "color bands" is refracted by the lenticulations to fall upon the vermilion filter-strip on the lens; and light from the emeraude and indigo bands is likewise directed to the corresponding strips of colored gelatine.

By the additive combination of varying intensities of V, E, and I light rays, all the colors originally photographed are reproduced on the screen.

Light Loss Thru Filters

The enormous loss of light occasioned by the filter strips is one of the most serious defects of the Keller-Dorian process, as it is also of *all* additive color-projection processes without a single exception. When Kodacolor 16-mm film was in use for home service, an aluminum-surfaced screen was necessary in order to obtain sufficient picture brightness. And even with a "specular" screen of this type, a picture no larger than 16½ by 22 inches could be obtained with a projector having a 200- or 300-watt incandescent lamp. Other serious deficiencies of this color process will be examined in detail.

Tests have been conducted quietly with 35-mm film stock embossed with lenticulations 0.03 mm wide—approximately 850 per inch on unshrunken stock. This is about as small as the lenticulations can be without introducing a disastrous loss of color values due to overlapping of two or more "color bands" (each slightly less than 0.01 mm in width) by clumps of reduced silver in the film emulsion.

Emulsion Silver Content

The so-called silver grains in photographic emulsion are really clumps made up of several grains stuck together in a solid mass. When exposed film is developed, an entire clump of silver bromide crystals is either reduced completely to metallic silver or not reduced at all. There is no "half-way" reduction. In the highlights of a photographic image, the clumps of reduced silver are comparatively far apart; in the shadows they are near together, hence much more numerous. The actual size of the individual clumps of reduced silver is influenced by the type of photographic emulsion and the nature of the developing chemicals used.

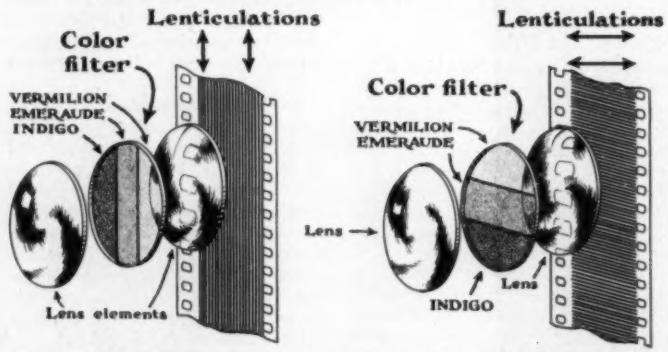
This overlapping, or "running together," of the color bands can be avoided by altering the form of the lenticulations and the thickness of the film base in order to separate the color bands by extremely thin blank bands. It is estimated that this measure, while improving the purity of the reproduced colors, would result in an additional 25% loss of light.

Screen Image Character

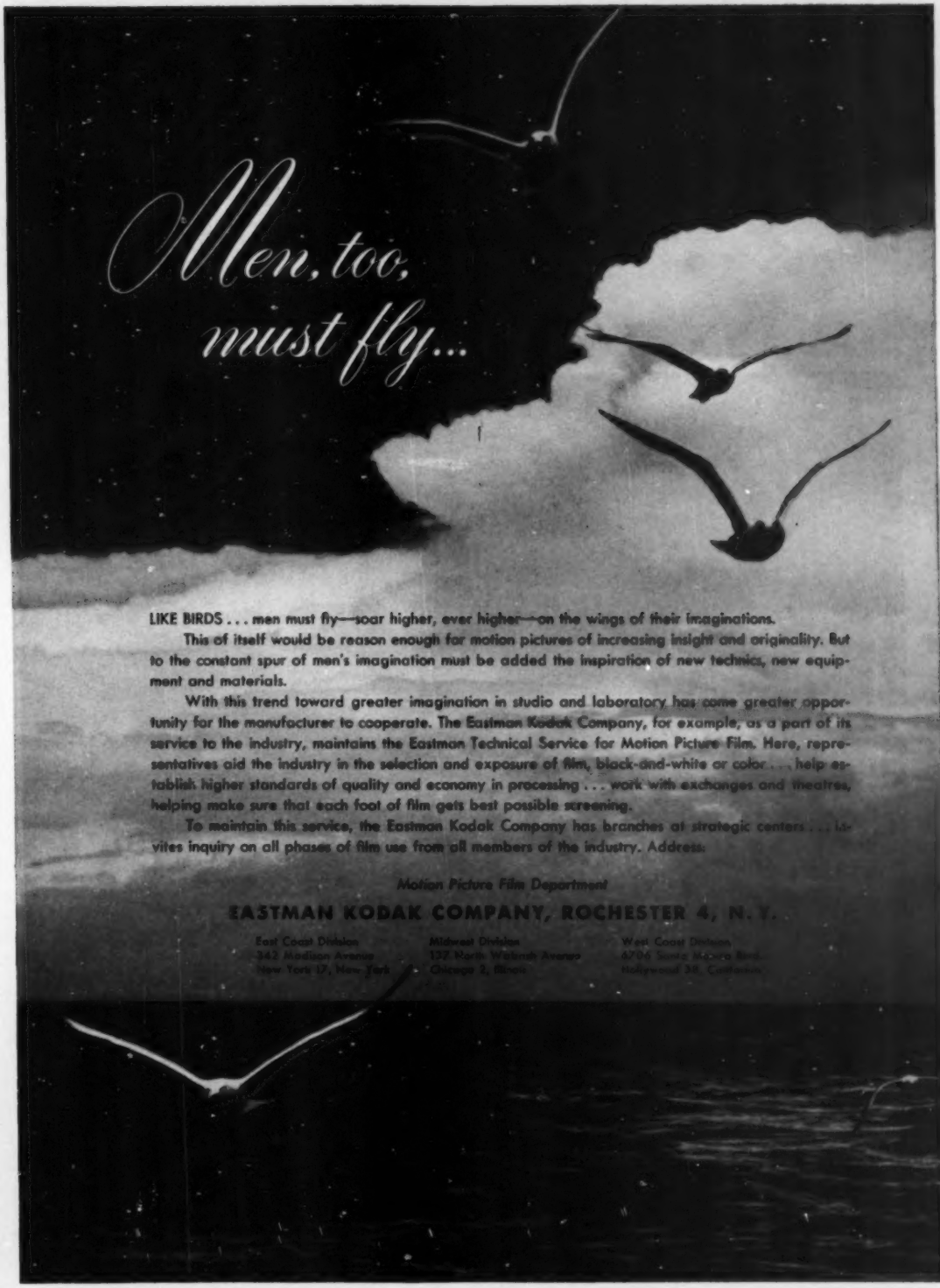
It might be thought that the lenticulations would show up on a large theatre screen as rather wide lines, because of the tremendous magnification of the picture in projection. Such is not the case. When the lenticulations are 0.03 mm in width, they are magnified to a width of 9 mm—almost ⅜-inch—on a 15 x 20 ft. screen. The effect is a slight fuzziness of focus, but the individual bands are invisible to the audience.

The inevitable loss of sharp focus is much more serious, however, when lenticulated *prints*, not reversal-processed *negatives*, are projected. Lenticulated prints cannot by any manner or means be made in a standard contact printer. They must be made by optical printing

FIGURE 1. TWO SYSTEMS OF THE LENTICULAR-FILM COLOR PROCESS.



When the embossed lenticulations of the film base run longitudinally, the filter must be positioned so that the three color-strips are vertical. If the lenticulations are lateral, the filter color-strips must likewise be horizontal. Note that the color filter is placed between the lens elements, whether in camera or projector.



LIKE BIRDS . . . men must fly—soar higher, ever higher—on the wings of their imaginations.

This of itself would be reason enough for motion pictures of increasing insight and originality. But to the constant spur of men's imagination must be added the inspiration of new technics, new equipment and materials.

With this trend toward greater imagination in studio and laboratory has come greater opportunity for the manufacturer to cooperate. The Eastman Kodak Company, for example, as a part of its service to the industry, maintains the Eastman Technical Service for Motion Picture Film. Here, representatives aid the industry in the selection and exposure of film, black-and-white or color . . . help establish higher standards of quality and economy in processing . . . work with exchanges and theatres, helping make sure that each foot of film gets best possible screening.

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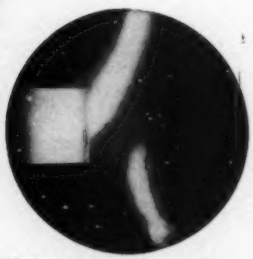

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through lenses having the three color strips over them. Loss of definition is doubled in the print, hence the sharpest line possible on a 20-foot screen would be a fuzzy band about ¾-inch wide. This figure assumes the use of a perfect propection lens, "on-the-nose" focusing by the projectionist, and it does not include the ever-present factor of normal emulsion graininess.

In short, lenticulated color is in a fog, as far as focus is concerned.

Filter Quality, Positioning

In order to obtain the best possible color from lenticular film, the color filters in the projection lens must be positioned with great accuracy in regard to azimuth and distance from lens elements. (Of these two factors, a slight error in rotational, or azimuthal, alignment is the less serious, since color-rendition efficiency in this single respect varies directly as the *sine* of the angle subtended by the direction of the film-lenticulations and the direction of the lens filter-strips.)

Moreover, the spectral characteristics of the three filter strips must be wellnigh perfect if any semblance to good color is to be reproduced on the screen. The vermilion filter must transmit only the vermilion region of the spectrum *without a trace of wavelengths lying in the emeraude and indigo regions.* The other two filters must have equally good spectral characteristics.

Filter Dye Factor

But even though such a vermilion (or emeraude or indigo) filter can be prepared, it cannot transmit *all* of the V or E or I) light, *but only a fraction of it.* This is because dyes which are perfect from the standpoint of spectral characteristics are far from efficient from the standpoint of light transmission. This unfortunate fact cannot be corrected until chemists discover new and better dyes—absolutely *perfect* dyes, in fact.

The Keller-Dorian process demands perfect filters—but perfect filters have not yet been made.

Summary of Deficiencies

If it be objected that even the (subtractive-process) dyes used for printing Technicolor films are not absolutely perfect, it should be borne in mind that a wide latitude of printing densities is available to Technicolor, making the process 100% efficient as to purity of color, and very nearly 100% efficient in regard to light transmission relative to standards set by black-and-white prints. Technicolor is a remarkably faithful and flexible process. The lenticulated-film process is not.

Why is the lenticulated-film process inherently inefficient in regard to color rendition? Because of:

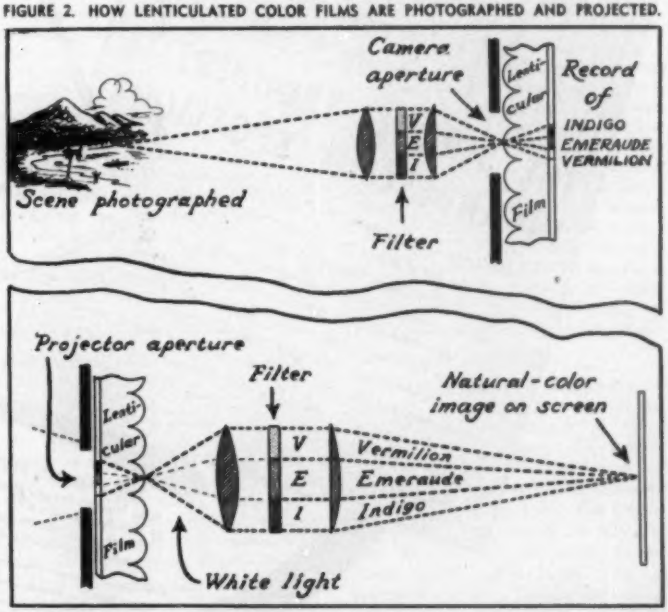
1. Unavoidable optical-positioning errors in camera and projector color filters. These arise from differences in the diameters, the focal lengths, and the design of camera and projector lenses.
2. Unavoidable variations in film-base thickness, due to shrinkage and other causes, deforming the lenticulations and resulting in spill-over of light onto the wrong color-filter strips, and even onto the walls of the lens-tube, "washing out" the color and wasting light.
3. Dirt and oil between the embossed ridges, cutting down light and destroying the extremely critical refraction and transmission balance of the lenticulations. Scratches in the film and otherwise worn and damaged lenticulations would cause spurious colors, "fluttery" colors, and low saturation of the reproduced hues.
4. Loss of color intensity in the printing process.
5. The impossibility of using spectrally perfect color filters in the projection lens (to minimize 1, 2, and 4, above) because of the very low transmission efficiency of such filters.
6. The dissimilar shapes of the three filters—two of them being segments of circles, and the middle filter a narrow oblong—and the anaxial optical positions of the two segment-shaped filters results in (*a*) objectionable color fringes when the projection lens is but very slightly out of focus and (*b*) *extreme color distortion,* altering the chromaticity of hues in a very unpleasant manner, whenever "vignetting" is produced either by the lens, the lamp optics, or both—which is usually the case in present-day equipment.
7. The impossibility of avoiding extremely objectionable color fringes on either the horizontal or vertical edges of out-of-focus objects in the picture. This spurious color-fringing is quantitatively much more serious than the chromatic aberration of simple uncorrected lenses, and it restricts lenticular color photography to the use of short-focus camera lenses to avoid out-of-focus backgrounds in closeups and out-of-focus foreground objects in long shots.

Cinematographers have always had available a wide range of lens focal-lengths for both standard black-and-white and color filming. The advantages of such a large assortment are obvious.

For example, the distance of the camera from a scene is sometimes fixed by the physical limitations of the set; yet perfect picture "composition" can be

(*Continued on page* 29)

FIGURE 2. HOW LENTICULATED COLOR FILMS ARE PHOTOGRAPHED AND PROJECTED.



No actual color, but only color values in black and white reside in the film. Color is supplied in projection by a 3-strip filter through which light is directed by the tiny film lenticulations, which act as cylindrical lenses.

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Projection in Britain's 'Telekinema'

A. BOWEN, J. MOIR, and H. TURNER*

report in "British Kinematography" on the visual and aural projection equipment and technique employed in the model Telekinema theater designed, equipped and operated specifically for the Festival of Britain.

MOTION picture presentations at the recent Festival Of Britain, held in London, were marked by several changes in equipment and technique which should be of interest to projectionists everywhere. As the British expressed it, "the Festival provided an opportunity to obtain public reaction to advanced ideas that have interested the technician for some time without finding adequate public expression."

Early discussion with Festival officials, followed by preliminary demonstrations in the laboratories, resulted in a decision to strive for the following objectives:

1. Projection of ordinary "flat" black-and-white and color sound films.
2. Replacement of the standard black screen border by an illuminated surround projected from the picture mechanism, the intensity and color of the surround being related to the average picture content.
3. A stereoscopic picture using polarized light.
4. A stereophonic sound system with additional "front-of-screen" sound effects.

Two standard 35-mm film projectors (SUPA's) were installed for the projection of normal sound films, the modifications for the projection of the illuminated screen surround, stereo picture film and other special features being added to the basic machine. The only modification required when projecting black-and-white sound film was the addition of a neutral light-absorbing filter in front of the projector to reduce the light intensity on the screen.

A special directional screen of high gain for the benefit of the Tv projector having been installed, it became necessary to reduce the screen luminance to tolerable values when showing film. This filter, and the Polaroid filter required for the stereo picture, were mounted in a disc mounted in a special housing bolted to the front of the projector, selection being made by rotating the disc to the required position.

Halochrome Border

Some pre-war investigations in the B.T.H.* Research Laboratories clearly demonstrated the disadvantage of the black screen masking border, the present standard practice. The war interfered with the commercial application of the alternative proposals, but the ideas were pursued for the Festival installation.

The black border is a relic of the early days of the industry when screen illumination was low and picture edges rather ragged, but it has become so much a part of a standard motion picture presentation that its presence is hardly questioned. That lusty newcomer, Tv, having a similar problem in masking off the picture tube, tried the film industry's solution, but abandoned it after a few months in favor of a light-colored surround.

Visual acuity is at its maximum when the detail to be appreciated presents the maximum contrast to the background, but the presence of a black border ensures that the maximum contrasts occur at the edges, thus reducing the sensitivity of the eye to the detail in the picture.

In addition to the loss of definition, the darker tones, especially of color films, in the picture are degraded by presenting them in comparison with the real blackness of the masking.

The requirement for optimum presentation of the picture detail and color is clearly that it should be presented against a neutral background such that the highlights are always *brighter* and the dark shadows *blacker* than the surround. These conditions are satisfied by projecting the surround lighting from the film projector in such a manner that the surround intensity and color is the average intensity and color of the picture at all times.

Screen Surround Unit

In the equipment discussed herein this is achieved fairly simply (Fig. 1) by making use of the light normally wasted during the pulldown period when the shutter is closed. The standard shutter is replaced by a special shutter with a reflecting rear surface to direct the light normally wasted upwards to a second mirror which reflects the light forward in a beam approximately parallel to the picture beam and slightly above it.

After passing through a heat filter, the light is directed by a condenser lens onto a full frame-size aperture in a position normally occupied by the framing aperture, and passing through the film is modulated in intensity and assumes the color of the picture. The color content of the transmitted light is then defocused or diffused to give a uniform color, masked to present the desired shape and projected by a corrected lens system which focuses the mask on the screen.

All the requirements of a perfect background are thus met in a simple manner: the average intensity and color of the surround can be related in any desired ratio to the picture and is automatically maintained without any manual control.

It cannot be emphasized too strongly that the purpose of a projected surround is not to compete with the picture for the patrons' attention, but to present the picture itself in the most attractive light. Considerable experience has convinced us that the advantage of a projected picture surround cannot be secured by any manually-operated device, however flexible in layout and operation.

Stereoscopic Pictures

Present techniques have not reached the stage where it is possible to present a stereoscopic picture to a large audience without making some compromise between what is desirable and what is possible, and in this instance that compromise involved the audience wearing spectacles.

Accepting this limitation as necessary, either two-color spectacles or polarizing spectacles can be chosen, and as the latter enable color films to be presented they have obvious advantages. The right- and left-eye pictures can thus be kept separated right up to the eyes of the audience, and the basic remaining problem is to decide on how the two images should be stored on the film and projected. It was decided to use two separate films, necessitating the synchronous operation of two projectors, the light beams being polarized at right angles by Polaroid filters carried on the projectors.

Requisites for Sterescopy

The requirements for a stereoscopic picture are that the picture should be seen in depth simultaneously by every member of the audience. This effect, either as in Nature or accentuated for dramatic emphasis, must be apparent even in the marginal seats. The brightness of the screen should be adequate from all seats and the whole screen should appear equally bright. This requirement provides conditions which help to produce the stereoscopic effect, which is really due to many factors.

The picture projected to each eye must contain the difference due to its par-

* British-Thomson-Houston Co., Ltd., London, England.

ticular angle of view, and be so presented that the angular position of the eyes of the audience changes with the near and far objects in the scene.

As the picture appears on a single static screen, the eyes of the audience must be focused on it whatever the apparent position of the object. Dut to the limited focal depth and power of accommodation of the eye, out-of-focus effects are obtained in ordinary life which aid the stereoscopic view: near objects are out-of-focus when the far ones are seen.

In static stereoscopic pictures the focus is usually sharp all over the picture area, so that time may be spent in looking from one object to another in the picture, the center of interest changing. With a motion picture this is less needed, and the principal object only may be taken in sharp focus to accentuate the stereoscopic effect, while the rest is out of focus.

Stereo Projection System

In the projection system it is necessary therefore to provide an optical system capable of giving definition sharp enough for the principal object to appear at any part of the screen, leaving the out-of-focus effects to the camera. Apparent depth in the picture is also assisted by a large angle of view, so that no real objects outside the picture come into view to spoil the illusion, for although many of the necessary factors are provided by the projection system, it still is the psychological effect in the mind of the observer which fuses the images to produce the three-dimensional picture.

This effect may be achieved by projecting each picture in the usual way, except that the two films must be in register on the screen and must be held in synchronism.

The use of two projectors requires that the lenses of the machines be separated by reason of the size of the machines, and to allow a projectionist to have access to both machines. This produces a parallax different in direction for each machine, and the consequent keystone effects in the horizontal plane are in opposition. The right-hand vertical edge of the left-eye picture is therefore longer than that of the right-eye picture, and *vice versa*. (Fig. 2).

Inter-Lens Separation

This effect also takes place right through the picture, and spatial distortion would be introduced if it were not removed. It is true that this effect is present in the view of a correctly projected picture, but in this case it must be that due only to the inter-lens separation in the camera, which is decided upon by the producer and varies according to the desired dramatic effect.

A rectilinear picture free from keystone effects from each machine is secured by offsetting the lens of each machine—the right-hand lens to the left, the left-hand lens to the right.

As mentioned previously, the right-eye picture is kept to the right eye by using a Polaroid filter between the projector and the screen, and by spectacles using Polaroid for each member of the audience. The screen must be capable of reflecting polarized light while retaining the plane of polarization. The planes of polarization are 90 degrees apart, and this gives transmission to one eye and a complete blackout for the other eye.

Each Picture Presented Twice

Each picture is presented twice at 24 frames per second, with a blackout interval between each exposure. We may therefore present the right- and the left-eye pictures alternately, so that the screen is always illuminated and a better continuity of vision is maintained than is the case with flat pictures.

The synchronous running of the two projectors is accomplished by the use of Selsyn motors which provide an electrical interlock between the two machines. The Selsyn motors are mechanically coupled at a one-to-one ratio to the normal driving motors. Using this arrangement, the electrical coupling has to take care only of the differences in speed of the two machines, and the torque transmitted from one machine to the other is very low. A chain and small-diameter bonded fabric sprockets are used to couple the Selsyn and driving motors to keep noise to a minimum.

Framing Adjustments

The framing adjustment normally used when the film is incorrectly threaded is now used to bring the two films into position to produce a right- and left-eye picture in register vertically on the screen. Horizontal register is achieved by lateral adjustment of the film in either gate, a pellet which steadies the guided edge of the film being provided with screw adjustment to effect this positioning.

In order to produce a rectilinear picture with the brightness curve centrally disposed about the screen center, the projector unit mechanism was set at an angle to the light source, so that the plane of the film in the gate is parallel to the plane of the screen.

The light source gives normal illumination, as its center line passes through the center of the picture aperture to the center of the screen. The projection lenses are mounted in the standard focusing holder with their center lines normal to the plane of the screen.

The screen has a front surface of fine grain particles each of which gives a special reflection and maintains the plane of polarization. The screen is curved in the horizontal plane, and coverage is obtained over the whole of the seating capacity with good uniformity of brightness over the whole screen surface.

Positioning of Projectors

Normally, the projectors stand directly on the floor, but here the projection room was located directly above part of the audience. It was necessary therefore to mount the projectors on anti-vibration mountings. These mountings are designed to give a periodicity of about 16 cycles per second in the vertical plane in order to be effective in reducing noise transmission to the floor.

The machines, being tall in proportion to their width, have a slow torsional period about the fore-and-aft line of the base, and this would have an adverse

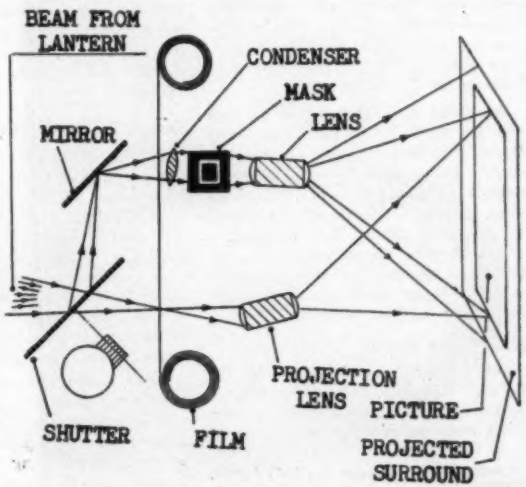


FIGURE 1

Showing the principle of the projected picture surround. The optical system for the surround appears above the standard optical system.

effect on the picture but for a bridge piece which braces the two machines and holds them together.

With the projectors mounted non-rigidly, it would be reasonable to assume that the picture as projected would be less steady than that from a similar projector rigidly mounted. It is found, however, first that the steadiness of each picture is still within normal limits, and secondly that in the stereoscopic picture the remaining movement disappears, giving a remarkably steady picture.

Stereophonic Sound

Present techniques of reproducing sound in the major theaters have reached a high level of performance, and there appears to be little doubt that further refinements of these techniques are unlikely to arouse intense public interest. In spite of this, it must be agreed that no audience could be deceived into thinking that the present electro-mechanical reproduction is the "real" thing.

Of the various possibilities, that of the three-channel stereophonic reproducer, with additional loudspeakers to reproduce special sound effects in the auditorium, seemed to be the most attractive, confirmation of which thought was obtained in an experimental installation. The superiority of three channels rather than two is readily apparent, particularly where dramatic action is to be reproduced.

The majority of acoustic close-ups always occur in center stage and the third (center channel) is invaluable in securing the necessary intimacy. It is noteworthy that Bell Laboratories came to the same conclusion after their tests in America.

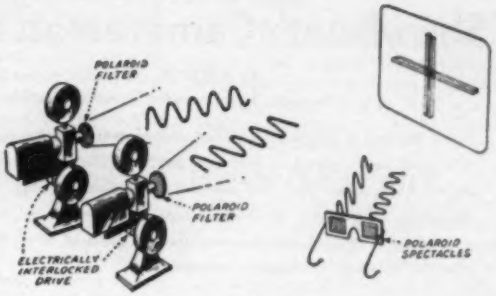


FIGURE 2
Diagram of a double projector installation using Polaroid filters on the projectors, plus viewing spectacles and projector interlock.

The dramatic appeal of sound effects produced in the auditorium, rather than from the loudspeakers behind the screen, was confirmed in first experiments, and at a very early stage in the discussions it was agreed to install additional loudspeakers in the auditorium back walls and in the main and under-balcony ceilings.

Independent Sound Tracks

Four independent sound tracks were therefore required, three for the stereophonic sound effects and one for the auditorium sound effects. Although experiment has confirmed that a wide frequency range is less necessary in a stereophonic system than in a monaural system, it was decided to make the system of wide range. In this and other respects magnetic recording has considerable advantages over present photographic recording techniques.

The provision of four tracks each of adequate volume range necessitated a separate film for sound only; but as this could be met by a relatively simple assembly of standard units, it was of no particular disadvantage in this installation. Synchronous locking of the picture and sound projectors is essential when separate machines are employed, but a locking system was necessary in any case for the projection of stereoscopic pictures.

The standard SUPA projectors required only minor modification in the electrical control system to use them in conjunction with the separate magnetic sound reproducers. Two standard rotary magnetic heads were installed for running magnetic film, each mounted atop

(*Continued on page 27*)

For the Record

Putting their best foot forward for the Festival of Britain exhibition, British film technicians designed and equipped a Telekinema Theatre which would acquaint visitors from all over the world with the trend of British thought in terms of things cinematographic.

Visual and aural attractions at the Telekinema included large-screen Tv, three-dimensional motion pictures, stereophonic sound reproduction, multiple film prints which utilized a projector interlock, and a means for eliminating the conventional screen masking by utilizing an accessory optical unit which literally "fed off" the standard projector setup.

One must admire the British "drive" under difficult economic conditions, but it must be said that the Telekinema offered little if anything that has not been done before. To recap:

Recap of Equipment and Processes

Large-screen Tv is old-hat not only in the U. S. but also in Britain. The simultaneous projection of multiple film tracks, with projector interlock, is also of comparatively ancient vintage, the most notable example of which probably was the roadshow presentation of Disney's "Fantasia" (IP for November, 1940, p. 20). Also in "Fantasia" was the first public demonstration of true stereophonic sound reproduction, using 36 speakers on the stage alone, with 22 small cabinet-type speakers scattered about the auditorium.

The Telekinema utilized *two* projectors plus analyzers (viewing spectacles) to achieve the three-dimensional motion picture effect. This procedure has been well known on both sides of the Atlantic for many years. IP hopes to be able shortly to describe a system creating the same effect which uses only *one* projector—plus analyzers, of course.

As for the means employed to eliminate the screen masking—an accessory optical unit—it would seem that our British friends did this job the hard way. Much more simple is the Schlanger method which utilizes no accessory units (described and shown elsewhere in this issue).

The foregoing comments are intended solely for the record and are not intended to detract from the progressivism of British thinking in motion picture technology. Constant hammering away at the tough problems in filmdom on both sides of the Atlantic might well provide the means for extending the life expectancy of the motion picture theatre far beyond the present horizon.

From the Production Front

'Showboat': Cameraman's Dream

By GEORGE SIDNEY
President, Screen Directors' Guild of America

This is the story of one phase of technological know-how that is poured into the making of a great motion picture, in this case the Technicolor masterpiece, "Showboat." The original source of the story, the *American Cinematographer* (Aug. 1951). We found it fascinating, an evaluation in which we hope IP readers concur. Ruminating upon the meticulous care lavished upon this production, we wondered on the quality of projection accorded "Showboat" in thousands of theatres.

THE degree to which people become absorbed in a motion picture, and become subjectively involved in a kind of emotional third dimension, is the measure of a picture's success. Because motion pictures are a visual medium, a successful picture often depends on the cameraman's skill in enhancing the action pictorially, leading the audience into this emotional state.

"Showboat" is an example of this cinematographic ingenuity. Throughout its entire length, it is replete with deft cinematic touches that point up a player's role or enhance a situation with observable effect on the audience.

Many unusual photographic problems were encountered in filming "Showboat." Most of them were anticipated early and plans consequently made for overcoming them in a series of pre-production huddles that took place before we started shooting. "Showboat" is the third picture in a row that Charles Rosher and I have made together; so by now we have become pretty much of a team.

Results Were No 'Accident'

Those "old master" touches in many of the colorful scenes of "Showboat" were no accident. They were the end result of countless sessions when together we pored over endless volumes in my library of art and photographic books. Whenever I showed enthusiasm for some particularly colorful or artistic effect in an illustration. Rosher would make a mental note on how to adapt it to some particular scene. I think this is best exemplified in the sequence of shots of William Warfield singing "Ol' Man River," which was actually filmed at dawn, in real fog. The low key result is a masterpiece in color cinematography.

There are a number of scenes in the picture, incidentally, where fog played a dominant part, pictorially. We took advantage of the fact we were producing this picture in December in Culver City, not far from the Pacific ocean, and used

Latest Maskless Screen Wins Audience, Technician Favor

Proponents of the maskless screen are enthusiastic about the recent installation of such a unit in the Plaza Theatre, Scarsdale, N. Y. Designed, fabricated and installed by Ben Schlanger who has waged a long and hard campaign for this unconventional reflecting surface, the Plaza screen represents the fruits of extensive tests under practical operating conditions over the past several years.

Both the screen itself and its immediate surround—sans masking, of course—are woven from the same fabric, thus permitting a vignette effect which permits the projected light to "spill" over on all sides with gradually diminishing intensity of light.

Patron Reaction Excellent

Patron reaction to this modern method of screen presentation was excellent, as indeed was that of the many technicians who witnessed the Plaza showing. This tallys with the reaction of patrons to the screen image in a Connecticut theater which has featured this form of presentation for the past three years.

Maskless screens are not new, of course, but it remained for Schlanger to give the idea its greatest impetus in America. In fact, Schlanger has been waging an arduous lone-wolf battle against the conventional type of masked screen, and it would seem that at last he has won approval for his idea in important technical circles.

An important aspect of the Schlanger maskless screen is that it can be "packaged"—that is, the individual theater can be equipped without the necessity for an on-the-spot, hand-tailored job. This feature is expected to be an important merchandising factor.

Schlanger holds that the original conception of a non-masked screen wherein consideration was given only to the physical means of seeing has long since been supplanted by the psycho-physical theory which gives precedence to the psychological effect of a vignetted screen image upon the viewer.

Screen Lighting Level Controlling

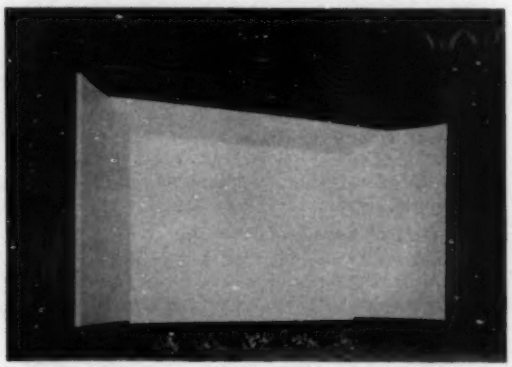
Only the low screen light level prevailing many years ago justified the use of a black screen masking says Schlanger. The comparatively high screen light level of today, he avers, has eliminated the need for screen masking, quite apart from any consideration of the greatly heightened dramatic impact upon the viewer which could be realized by the elimination of masking.

The original Schlanger proposal was that the light passing through the edges of an unmasked screen should be so utilized that it would vignette off on all sides of the picture area and illuminate an appropriate surround. This method was held to be applicable with equally good results to both black-and-white and color films.

Additional installations of the Schlanger maskless screen will be made shortly, one in a large Broadway house.

THE SCHLANGER MASKLESS SCREEN SURROUND IN PLAZA THEATRE, SCARSDALE, N. Y.

Showing how the screen surround appears in relation to the proscenium and sides, and to the front rows of seats. The surround is made of the same material as the screen, with no accessory optical unit being necessary.



the naturally foggy atmosphere for these scenes. Frequently the natural fog in scenes was amplified through skillful use of filters or by addition of artificial fog.

Sometimes, having started to shoot a sequence of scenes under foggy weather conditions, we ran into serious trouble. The fog would lift suddenly and the sun would come out. This called for one of three alternatives: to employ artificial fog and filters, go indoors on the sound stage, or move to another exterior location that called for shooting in full sunlight.

Fog—and Light Balance

Fog, being an elusive thing, became one of our major bugaboos when shooting exteriors on the studio's lot three. It moved in clouds of varying density, creating troublesome exposure problems. We frequently had to depend on constant visual checks of the light, so rapidly did light quality fluctuate. Strict attention to this detail enabled the cameraman to retain remarkable density balance from one shot to the next.

Still another problem was maintaining balance in the lighting when shooting a sequence of fog scenes over a period of days. No two days were alike in light quality. It thus was necessary to keep in mind the light conditions that prevailed each preceding day in order to match it and insure the desired continuity of light quality and direction.

As every cameraman knows, it is relatively simple to shoot in normal sunlight; but battling the elements calls for more than ordinary camera skill. The successful director of photography must be resourceful enough to meet changing light conditions without delay, no matter how severe or how frequently they occur.

A 'Mental Encyclopedia'

Such mid-winter weather conditions demonstrated how important is the cameraman's ability to maintain a sort of mental encyclopedia of detail from scene to scene, where such scenes are not filmed consecutively. He must have an infallible memory for the quality, color temperature and direction of the source of light.

For instance, we were shooting the picture in December; days were short. There were days that dawned foggy or extremely cloudy, forcing us to go indoors and shoot on the sound stage. Then the sun would come out suddenly, and because sunshine was such a precious commodity for the vast number of exteriors we had to shoot, we would halt indoor shooting and move out-of-doors again, shooting until color temperature of the light went below the point where it could be balanced satisfactorily. Then we'd go back indoors, only to find, perhaps, that one of the cast was unavailable; so we would then switch to another set. Two weeks later, we would return to the first set and resume shooting there.

It was Rosher's uncanny ability to remember all the camera and lighting details of the original setup that enabled the company to resume shooting as though there had been no interruption. The subsequent takes matched exactly in lighting continuity and quality those made the day shooting first started on the set.

Color Temperature Vital

There are two things in which Rosher excels: his scrupulous attention to continuity of lighting direction from one shot or sequence to another, and his constant vigilance over the color temperature of set illumination.

We both agree that the whole future of color photography is bound up with color temperature, that it is a most important factor in color cinematography, affecting as it does the purity and consistency of color rendition. It is necessary for cameramen to know this when shooting color if skies are to match from scene to scene, and faces and complexions of players are to remain constant from one scene to the next. I think "Showboat" is outstanding for these very consistencies.

Consistency in facial renditions were achieved without resorting to overlighting by reflectors or booster lights. A notable example is the scene, early in the picture, where Howard Keel and Kathryn Grayson, singing together on the upper deck of the showboat, move about—sometimes in partial shadow and then in full sunlight. Also, later in the picture, when Ava Gardner is singing "Can't Help Lovin' That Man" on the afterdeck. She moves from one side of the boat to the other—in and out of sunlight—and there is no appreciable change in her facial rendition, photographically, due to skillful maneuvering of the lighting.

These scenes particularly demonstrate what is becoming more and more self-evident: that candid-type photography has at last come into its own in cinematography—candid in that there is more realism in the result, less of the "forced" photographic effect.

Developing Pictorial Emphasis

Many of the memorable camera treatments in the picture were conceived right on the set or location. From a compositional viewpoint, one of the most impressive is the shot of Howard Keel walking along the river's edge. The camera, slightly elevated, looks down on Keel and shows reflections of the gaily decorated showboat in the water behind him —an impressive and colorful backdrop. It was one of those opportunities for pictorial emphasis which was developed to the fullest.

Another example occurs early in the picture. One of the crew, after being severely beaten by Robert Sterling for forcing his attentions on Ava Gardner, leaves the showboat in a rage and goes up the river bank in search of the sheriff. This could have been an ordinary shot made from a simple camera setup on the crest of the river bank, picking up the man as he trudged up the hill. But we saw opportunity to gradually heighten the effect of the man's anger through pictorial emphasis that would make him loom larger as he approached the camera.

Dolly tracks were laid from the crest of the hill, extending out toward the boat on a scaffolding, and paralleling the uphill path. The Technicolor camera, mounted on a movable crane, was set to start the shot from the far end of the track—nearest the boat. As the man left the boat below, the camera was started and the crane pulled back; meanwhile, the boom was gradually lowered until the camera now was below the level of the dolly tracks, almost at ground level. Here it looked up at the raging boatman looming ever larger, and at the same time showed the boat in the distance for a unique compositional effect.

Difficult Location Problems

One of the classic shots in the entire picture is one we filmed on location on the Mississippi river. Prior to starting the picture at the studio, Rosher and I went to Vicksburg, Miss., to shoot scenes of the river packet on which Howard Keel and Ava Gardner meet again, in the latter part of the story. On an earlier location-scouting trip I had located the "Sprague," an ancient river boat tied up at a wharf, where it now served as a

(*Continued on page 26*)

Red Feather Volunteers

The United Red Feather Campaign in your town needs you as a volunteer solicitor in this fall's big drive for funds.

Your United Red Feather drive is a part of one great national effort to support more than 15,000 local health, recreation and welfare services. New inclusions this year are the reactivated USO and other voluntary health and welfare agencies which are now needed because of the defense effort.

More than a million and a half volunteers are needed to do the job. Volunteer your time now to your UNITED RED FEATHER CAMPAIGN.

IN THE SPOTLIGHT

By *HARRY SHERMAN*

MOST welcome is the news that RCA has reprinted in compact form under one cover the six articles on the RCA PT-100 Theater Tv system which were written expressly for and ran in serial form exclusively in IP. We say this news is most welcome not to win any "puff" for IP but because for several weeks past now we have been deluged with requests for copies of these articles not only by those who had missed the series but also by those who having read the articles wished to obtain them in compact form.

RCA has reprinted many thousands of these booklets, the content of which was slanted directly at projectionists, and nation-wide distribution is now being effected through the RCA district offices. It is not unlikely that the current supply will soon be exhausted and that a further reprint order will be placed.

IP regrets that it cannot service the many requests for this booklet, since the physical distribution is being handled by RCA. Inquiries concerning the booklet should be addressed to the Theater Equipment Section, Engineering Products Dept., Radio Corp. of America. Camden, N. J.

The aforementioned circumstances demonstrate once more the wisdom of those regular subscribers to IP who don't have to stretch a shoelace to be kept well informed on technical developments each month.

• The greatly expanded activities of the IA have made it necessary to move its general offices to larger quarters. They are now located in the RKO Building. Suite 1900, 1279 Sixth Avenue, New York 20, just one block west of its former headquarters.

• Frank Kinsora, president of Detroit Local 199, was in charge of the Coliseum during the recent Michigan state fair. Roadmen working on the job all spoke very highly of Frank.

• A recent NLRB ruling ordered the immediate reinstatement plus back pay of Kenneth Caraway, who was discharged from his job as projectionist at the Fox Theater in Coffeyville, Kans. The Board examiner found that "certain interests brought pressure on the Fox Midwest Amusement Corp. to fire Caraway, thereby violating the Taft-Hartley Law."

• Matt Kennedy, former business representative for Local 273, New Haven, Conn., figured in a car smashup that almost cost him his life. Matt and Mrs. Kennedy were driving through the outskirts of Utica, N. Y., en route to Canada where they planned to spend their vacation, when a large truck rammed into the back of their car, completely demolishing the trunk compartment and the rear seats. Miraculously, the Kennedys escaped serious injuries, and outside a few minor bruises and a pretty bad scare they were none the worse for their experience. Their baggage, of course, was destroyed, and the Canadian vacation was indefinitely postponed.

• A banquet at the Bel Sito Restaurant on September 19 marked the 40th anniversary celebration for Local 221, Aurora, Ill. Clinton R. Graeff, president of the Local, presented charter member buttons to Henry H. Anderson, Charles O. Doane, Ralph I. Pulver, Raymond L. Fox (vice-president of the Local), and Walter B. Kline. Serving on the arrangements committee were Ralph Johnson (secretary-treasurer), Phil Duggan and Raymond Fox.

• Roy M. Brewer, IA Hollywood representative, was appointed as one of the two AF of L members on the Wage Stabilization Board for California, Arizona, and Nevada.

• We are glad to learn that Bill Maxon of Syracuse Local 376 has recovered from his protracted ailment and is once again back on the job. As vice-president of the AF of L Union Label Council, Bill was instrumental in having each theater in Syracuse display a special poster in connection with the recent Union Label week.

• Movietime in Texas was celebrated several weeks ago in conjunction with the nation-wide Movietime USA campaign. Typical of the cooperation of IA Local Unions in this campaign was the advertisement placed in a local newspaper by Local 548, Paris, Texas, a reproduction of which appears herein.

UNION LABOR BACKS MOVIETIME USA

UNION LABOR endorses

Motion Picture Theatres, indoors as well as outdoor, join the 1,500 other Movie Theatres of Texas in the celebration of MOVIE TIME IN TEXAS. Attend a movie at any theatre. Enjoy yourself in any one of the eight Movie Theatres in the Paris area — always fine entertainment at a modest price.

Moving Picture Machine Operators
Local No. 548 — Paris, Texas

Here is an example of the cooperation extended by IA Locals throughout the country to the Movietime USA campaign to spur theatre attendance. In every instance the ad space was paid for by the unions.

• It has been suggested to this department by a number of our readers, many of whom are IA members of long standing, that it would be a nice gesture on the part of IA Local Unions to present each retiring member with a card upon which appears his union affiliation, date of retirement, and such other data as may be deemed pertinent. The card need not be expensive—just small enough to carry in a regular card case, and will serve as a memento of many years' membership in the union.

• Bert Ryde, popular business representative for Buffalo Local 233, was a recent one-day visitor to New York. He accomplished his mission shortly after his arrival, turned around and headed back for Buffalo the very same day.

• Film Post No. 1292 of the American Legion, formed by members of New York Local 306, held its annual election of officers. The newly elected officers are Al Sprung, comander; Moe Singer, 1st vice-commander; Harold Salkey, 2nd vice-

commander; Harry Klein, 3rd vice-commander; Archie Hollander, hospitaler; Frank Miller, adjutant; Edgar Heidelberg, financial officer; Francis Costa, sergeant-at-arms, and Harry Waks, chaplain. A. S. (Steve) D'Inzillo and Al Sprung were named to the entertainment committee.

• George Ernst, projectionist at the Grand Theater, Grantsburg, Wis., was severely burned about the face while he was adjusting his projection equipment during an electrical storm. It is believed that a flash of lightning entered a vent pipe running from the projection room to the outside of the building, causing a fire that destroyed the equipment in the projection room and injured Ernst.

• Hugh J. Sedgwick, secretary and business representative for Local 303, Hamilton, Ont., Canada, was the first film man chosen to represent Canada at Britain's recent Trade Union Congress. Sedgwick was the first fraternal delegate of the Canadian Trades and Labor Council. He is active in Canadian Labor circles, and his public service activities include service on the Board of the Hamilton General Hospital and the chairmanship of the Hamilton Planning Board.

• We sympathize deeply with Leo Barber, business representative for Local 245, Lynn, Mass., on the recent death of his wife, Constance. Leo has held office in the Local for many years and is popular in Labor circles.

• Morris J. Rotker, member of New York Local 306 and chairman of the Cerebral Palsy Committee in this city, advised us that he was overwhelmed with the response from IP readers to his recent request for old and discarded greeting cards for the victims of cerebral palsy. He was so deluged with cards from all parts of the country that he has requested us to thank the senders and to ask that no more cards be sent to him. His supply on hand is more than sufficient for his needs.

• We had occasion recently to spend several weeks on the road with a legitimate play utilizing projection. One function, of course, was to run the projection machines. New Haven, Conn., was our first stop, and there we met for the first time Frank Perry, the newly-elected business representative for Local 273. Perry was very gracious and we think the members of the New Haven Local are fortunate in their choice of business representative.

Boston was our second stand, for a three weeks' run, and there we were greeted by Walter Diehl, business representative for Local 182. The Boston boys were most cooperative, particularly Joe Cifre, former president of Local 182 and now head of the supply company bearing his name. We had a little difficulty in setting up our equipment and Joe delegated two of his installation men, Dave Fox and Alfred Otika, to correct the trouble. Fox and Otika, members of Local 182, proved their efficiency by keeping the machines running in tip-top shape during the Boston run of the show.

Our thanks, too, to RCA serviceman Holmquist, who did a swell job on the projectors, and to all those who assisted us in the very successful operation of the equipment.

• For the first time in its 32 years of existence, Local 565, Centralia, Ill., has been forced to resort to picketing in trying to reach an agreement with an exhibitor in its jurisdiction. The owners of the Centralia Drive-In Theater, Homer and Elbert Butler, refused to renew their contract with the Local at the opening of the 1951 season and locked out the union projectionists, running the projection machines themselves. The union officials did not ask for an increase in wages for their members—they were willing to renew the contract on the same terms provided for in the 1950 contract, covering regular and relief projectionists, but the Butlers balked. Organized labor in Centralia rallied to the support of Local 565 and is helping the union both financially and morally.

• The newly formed El Bekal Shrine of Long Beach, Calif., elected two IA men to head its stagecraft unit. Mace Taylor, member of Los Angeles Local 33, was elected president, and Alonzo B. Bennett, secretary of Long Beach Local 521, was named secretary of the unit, in addition to being appointed chairman of the projection and spotlight departments. Max G. Miller, former president of Local 521, was named chairman of the sound department.

TWO ARCLIGHT CHAMPS IN HOLLYWOOD

Fred C. Stevenour, representative for National Carbon Co. in Memphis, pictured with his daughter, movie actress June Haver, who has helped to consume much of her dad's product.

•

HUGH SEDGWICK

IA man Canada's delegate to British Trade Union Congress.

•

The new temple was granted dispensation by the Imperial Shrine Council at the last national convention, and in El Bekal's ranks will be found many "Nobles" carrying union cards.

• Negotiations between Vancouver Local 348 and the Famous Players circuit of Canada have reached an impasse with the Local's refusal to accept a 28c per hour increase recommended by a conciliation board. The Local is asking for an increase of 50c per hour, basing its demand upon the increased cost of living index, which, it is claimed, has reached an all-time high. We understand that the officials of the Local have appealed to the British Columbia labor relations board for a government-supervised strike vote.

25 Years Ago—October 1926

• The new edition of the International By-Laws carried a change in Article 2, Section 21, (page 44), passed at the Cleveland Convention in June of that year, applicable to new members. Heretofore it was necessary that an applicant reside in the jurisdiction of the Local Union to which he made application for membership for a period of only six (6) months. The law now reads that the term of residence be eighteen (18) months, and all Local Unions were instructed to see that this new provision was properly enforced. . . . The General Executive Board met at the Hotel Ft. Wayne in Detroit, Mich., hearing charges and appeals. . . . Producers on the West Coast were notified by the International Alliance, the United Brotherhood of Carpenters and Joiners, International Brotherhood of Electrical Workers, and the United Scenic Artists of America that in the event complete unionization of the West Coast studios was not completed by December 1926, a general strike would be called. . . . Per capita tax to be paid to the General Office was increased to 85c; this included convention transportation and per diem taxes. . . . The General Executive Board approved the action of IA President Canavan in donating $1000 to Local 545, Miami, Fla., in response to an appeal for assistance after the recent hurricane.

The Allied Arts and Sciences

A vast field of artistic and scientific endeavor is directly contributory to the motion picture process and, therefore, to the practice of projection. The true craftsman should have a well-rounded understanding of these contributory factors, particularly in view of the imminent widespread utilization of television and, possibly, stereoscopic pictures and stereophonic sound. To this end, IP here inaugurates a special department which will provide basic information on the aforementioned arts and sciences.

II. Photographic Optics (Distortion)

Bausch & Lomb Optical Company, Rochester, New York

THIS is the latest of the five monochromatic aberrations, and the one in no way affecting the sharpness of the image. This aberration changes the point-for-point mapping by the lens, so that the sharp image points do not correspond in all respects with the positions occupied by the original object points. The mapping becomes inaccurate in a regular manner, or, expressed more scientifically, the magnification is not uniform over the field of the lens.

This latter is perhaps the best way of visualizing the optical designer's distortion, which should be carefully distinguished from the distortion introduced by a wide-angle lens. The latter is strictly a perspective distortion, while the former can be called a mapping distortion.

If the magnification of a lens is a function of the field angle, one cannot expect to image a square centered about the axis of the lens as a square, but as some queerly-warped figure.

'Pincushion' Distortion

More characteristically, since a straight line near the edge of the field is an object lying at varying angular distances from the axis of the lens, one cannot expect to image that line—be it posted, door lintel, *etc.*—as straight, but must expect to find it curved. In a lens afflicted with distortion, the post will be curved either toward or away from the center of the field, depending upon the type of distortion present.

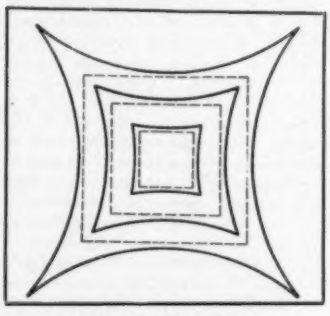


FIG. 14. 'Pin-cushion' distortion.

If the magnification in the field is greater than that along the axis, a centered square will present the appearance of a pincushion, with corners sharp and less than 90°, and straight lines will be imaged as portions of curves

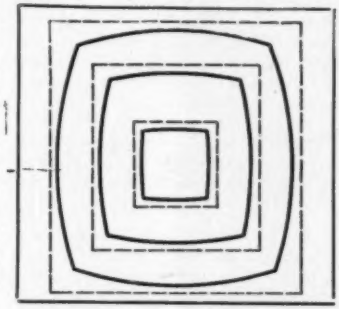


FIG. 15. 'Barrel' distortion.

convex to the center of the field. It is for obvious reasons that this aberration is called *pincushion distortion* (Fig. 14).

'Barrel' Distortion

On the other hand, if the magnification is less in the field, a square will resemble a perspective drawing of a barrel, and lines in the margins will be curved toward the axis. The appellation *barrel* for this type of distortion is readily justified (Fig. 15).

Distortion is controlled by the lens designer through the choice of stop position and the distribution of powers throughout the system.

No matter how far we stop the lens, the distortion will remain unaffected. This aberration cannot influence the sharpness of imagery. Distortion, however, is more sensitive to image height than any other aberration we shall consider, varying as the cube of the height; whereas coma and lateral chromatic aberration vary directly, and astigmatism and field curvature, as the square of the image height (Fig. 16).

Distortion is a very important aberration where the metric properties of the negative or print must be considered, as in copying, template work, or aerial mapping. In these cases, symmetrical lenses are usually used, which have the advantageous property of having theoretically zero distortion when working at unit magnification, and very little while working at any other magnification. When measurements must be made on photographs, the distortion of the lenses used is determined and allowed for.

In most photography, distortion is of small consequence, having been brought to such a level in modern lenses that highly-refined tests must be employed to detect it. For that reason, it is seldom seen in our negatives and prints.

The Two Pure Color Aberrations

Each of the preceding aberrations will differ in different colors, but there are two distinct aberrations arising because of color itself, two aberrations independent of any consideration except color. Before we discuss these chromatic defects of lenses, we shall have to consider in more detail exactly what happens when a ray of light strikes our lenses.

In empty space, light travels at the rate of 186,000 miles per second. When traveling in matter (transparent, of course) the speed is necessarily somewhat less. In fact, the velocity of a light-wave is one of the most important characteristics of a transparent medium (vacuum having the maximum and optically more dense media having progressively lower velocities). This velocity is a measure of the bending or refractive power of a medium: the lower the speed of light inside the medium, the greater is its ability to bend light, and *vice versa*.

The reason for this is seen in the consideration of the diagram illustrating refraction for a beam of light. Upon the basic fact of refraction at a glass-air boundary, or the boundary of two dissimilar media, is raised the whole science of optics as it interests us here (Fig. 17).

Refractive Index of Media

Nature, doing things with a lavish hand, not only permits slowing light upon entering a dense medium, but permits different colors travelling with different velocities. In fact, in common glasses,

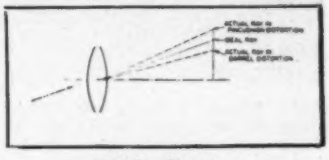


FIG. 16. Distortion.

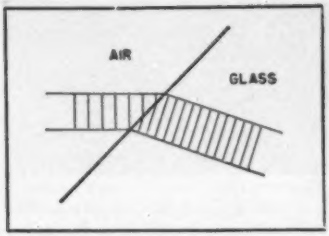


FIG. 17. Refraction.

red light travels as much as 4000 miles per second faster than violet or blue light. This has the natural effect of tieing the bending power or *refractive index* to the color of the light considered, which means a different index for red than for violet light (Fig. 18).

The index for blue light is always higher than for red light, the difference between the two expressing the dispersive power of the medium, since it measures in effect the spread of a spectrum, or rainbow, produced by a prism of the material.

Now consider a lens receiving a bundle of parallel light. Each element of the lens acts as a prism, refracting the light toward a general region on the axis (Fig. 19). For the moment, neglect spherical aberration and consider the effect of the colors constituting white light.

As noted previously, blue or violet light will be refracted more than red light, and would thus be brought to a focus closer to the lens than would the red. The distance between the lens vertex and the mean focus is dependent on the glass index, being smaller the higher that index. The distance between the blue and red foci is a function of the dispersion of the glass, being greater the larger that dispersion.

This difference of focal points in different colors constitutes the first of our chromatic aberrations: *longitudinal chromatic* aberration, or separation of focal point. It is easily seen that this defect is of major importance in photography, for, as is seen from the diagram, in the presence of this aberration there is no single focal point: the image is soft, consisting of vari-colored discs.

The situation would not be too bad with blue-sensitive film, for then, after a shift to compensate for the "chemical focus," a fairly sharp image could be obtained in blue light (Fig. 20). If either orthochromatic or panchromatic film were to be employed, the situation would be hopeless, the film registering little but the large circles of confusion.

Chemical focus is seen in infra-red work, where the manufacturer recommends focusing the lens out a trifle for best results. The infra-red focal plane is farther from the lens than the visible, *i.e.*, the lens is afflicted with longitudinal chromatic aberration in the infra-red, and the outward shift is to compensate for this.

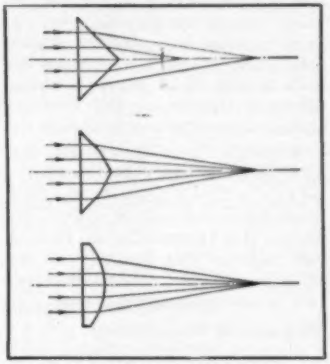


FIG. 19. Lens as prisms.

This aberration justly receives prompt attention from the designer, being one of the very first to be corrected. All photographic objectives except the very crudest have been corrected for longitudinal color.

We saw previously that, because of the twin factors of refraction and dispersion, a parallel beam of white light is broken up by a positive lens into a series of focal points, the blue coming to a focus sooner than the red. Further, we saw that the distance between these two foci varies with the dispersion of the glass, being greater the greater the dispersion. The only way to achieve *achromatism* of the focal points is by some dodge to annul the dispersion of the glass, while at the same time not completely canceling its refractive power.

In practice, this is achieved through the expedient of using a negative lens of a glass of higher index and dispersion with the positive lens (Fig. 21). The negative element has its power and dispersion so chosen that the dispersion between two chosen colors of the positive element is effectively cancelled, while its power is not quite annulled: thus, a real focal point does exist for the two colors achromatised. In doing this, the spherical aberration of the combination is usually corrected through the expedient of "bending" the lens—that is, changing all the curves by the same amount.

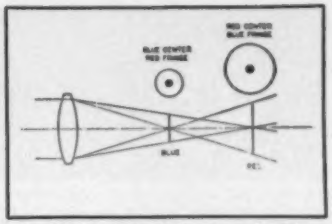


FIG. 20. Longitudinal chromatic aberration.

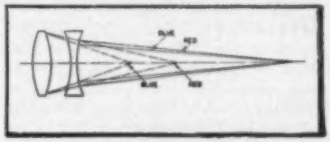


FIG. 21. Longitudinal achromatization.

It is to be noticed that we have spoken of achromatising the focal points for two colors only. Unfortunately, it is possible to correct with two lenses but for only two colors. The slight amount of *secondary color* inevitably left in even the best objectives is too small to be of much concern. The focal points of the colors not specifically achromatised usually lie fairly close to the common focus of the colors for which the lens was corrected.

But it is not sufficient to provide a common focal point for light of various colors. True, with this axial achromatism effected, a sharp image will be found in all colors on the axis; but off axis there might be a color fringe about objects. Let us see how this might occur in a lens having a common focus for blue and red light (Fig. 22).

We saw earlier that the equivalent

(*Continued on page 24*)

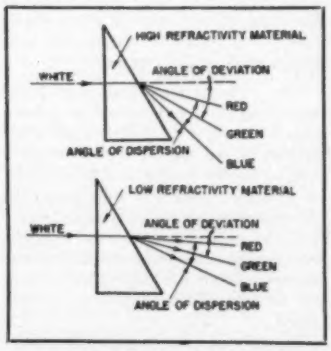


FIG. 18. Refraction and dispersion.

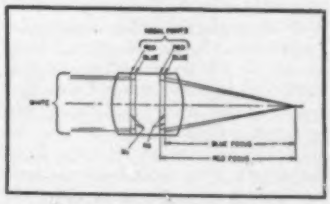


FIG. 22. Lateral chromatism, I.

Feverish Tv Activity on all Fronts; Theater Stake

BRASH indeed is anybody who would hazard a prediction as to the ultimate significance of Tv developments on both the home and theater fronts within the past month. But even a straightaway recounting of such happenings is enough to excite the imagination.

First, the word about that old theater Tv standby—prize fights. The Robinson-Turpin exclusive fight broadcast was a tremendous success in every theater where it was shown. In fact, in a couple of spots the crowd got a bit unruly—notably at the State-Lake in Chicago, where a surging mob crashed through the lobby doors and grabbed whatever seats were available. This gave industryites no little concern in terms of its effect upon their regular patronage for movies.

Sports Promoters' Bonanza?

The film industry then delivered another sock at home Tv when RKO had 300 film prints of the fight in theater circulation within 24 hours. Theater Tv plus theater film, with its lush take practically convinced sports promoters of the desirability of nixing home Tv-radio broadcasts.

Two weeks later the Pep-Saddler brawl did not do so well on the theater Tv circuit; but the optimistic view in film circles was that the seating capacity of Tv theaters now operating is 2½ times the seating capacity of the Polo Grounds, N. Y., where the fight was staged. Tending to prove that it still is a basic question of a quality attraction—"the show's the thing."

Scores of Tv Color Tubes

Theater Tv equipment manufacturers were feverishly active. Paramount (intermediate-film system) appointed Century Projector Corp. exclusive distributor of its theater units. Paramount also pulled a fast one when it produced in New York a world-famous atomic scientist, Nobel-prize-winner Dr. E. O. Lawrence, of the Univ. of California, and demonstrated a "revolutionary" new color tube. Oddly enough the first demonstration was given exclusively to science writer Wiliam Laurence, of the *New York Times*, who wrapped up the first atom bomb story for all newspapers on behalf of the U. S. Government. Nice going anent personnel and timing, with Par stock rising six points the day following.

Strangely enough, writer Laurence was present the following day at a demonstration of the RCA color tube, and he rather surprised the assemblage by declaring that the RCA tube was the better of the two! Paul Raibourn, Paramount v.p., "admitted" that the RCA tube was "just as good as ours," but that the Par tube was "cheaper to make."

In passing, it may be said that the Lawrence tube is not "revolutionary." In fact, there are more than 50 different ways to make such a color tube; and back in 1940 Dr. A. N. Goldsmith invented 20 different ways, while disclosing up until recently only three of them.

Meanwhile, Spyros Skouras, 20th Century-Fox prexy, hied himself to Switzerland for a further look-see at the Eidophor Tv system, which utilizes the Ventarc H-I "blown arc" of Dr. Gretener (IP for July, 1950). Skouras, enthusiastic anent Eidophor, says that Fox will soon be merchandising this system.

Tv Scores at TOA Meeting

Theater Tv stole the show at the recent Theater Owners of America convention in N. Y. RCA, Paramount, General Precision Labs., and Trad-Tv Corp., the latter pushing a set for the smaller theaters, went all-out to impress Mr. Exhibitor. RCA (direct-projection) said that it had a backlog of 100 orders which, at the present rate of production, it expects to deliver by Jan. 1 next. This system costs $16,500, plus about $2000 installation expense. Paramount has 10 of its intermediate-film equipments in work, with delivery date uncertain. This equipment costs $25,000, plus $2000 for installation.

GPL reports 43 orders on hand for its two systems, this company being the only one to date to offer both intermediate-film and direct-projection equipments. The film equipment, similar to the Paramount unit, is priced at $35,000, but since 16-mm film is used *via* a special projector, GPL claims radically decreased operating costs. The GPL direct system costs about the same as the RCA job, with production now underway.

The newcomer to the field, Trad, is offering a simplified system which is obviously pointed at the small-theater field. Two Trad units are available—one at $3500 and the other at $7650, with installation costs estimated at under $1000.

Significantly, practically all sponsors of theater Tv systems predict that the movie theaters will have color Tv *via* a closed circuit long before it ever reaches homes on a large scale. Paramount, through its Chromatic subsidiary, avers that color Tv is a cinch right now; while Fox asserts that not only will its Eidophor system run first in the color derby but will also give the best color rendition.

RCA Theater Tv Color Show

RCA made a quick decision in favor of action, not words. It hastily organized a full week's showings of *large-screen, color theater Tv* at the 1200-seat Colonial Theater (N. Y.). Viewed on a 9 x 12-ft. screen, a 20-minute show built around musical comedy actress Nanette Fabray was shown to very good advantage *via* the three-color compatible, all-electronic system. Morning show, in fact, was seen locally in black-and-white on home sets over Channel 4, as well as in Washington, D. C., on the same channel number there, *via* coaxial cable and radio relay. Further, color Tv receivers were set up in the lounge of the Center Theater in Radio City where the public was invited.

Color Tv Projection Unit

The experimental receiver-projector was set up in the orchestra, about a dozen rows back, while the audience sat in the balcony. It wa explained that it would now be possible to obtain a greater thrust on a larger screen with more recent developments which could be incorporated into new models, and that widening the 6-megacycle band would result in greater definition. Moreover, the brightness could be doubled, RCA engineers present stated.

Projector housing contained three separate projection kinescopes—for red,

Tv Stations vs. Saturation

Confirming general observation, recent statistical studies have shown that in markets where there was only one television station, the average Tv receiver saturation was 28.7%. The saturation figure goes up to 33% in markets with two stations; to 46.3% in markets with three stations, and climbs even to 59.1% in markets with four or more.

blue and green—with three images passing through correction lenses and then synchronized on the screen. In general, reception was comparable to home Tv reception: closeups showed well, while backgrounds blurred too easily. Audience reaction was obviously quite sympathetic with the few mechanical shortcomings, however, and was generally enthusiastic about the color values.

At the TOA convention it was disclosed that the film industry is seeking assignment of six channels in the 6000-megacycle range, far above the radio and Tv bands, which will enable color transmission. The request will be on a strictly commercial basis in that admissions can be charged.

Described by Sam Pinanski, retiring TOA prexy, as a "showmanship approach" was the suggestion that regional theaters finance their own productions of whatever character—musicals, fights, operas, football games, *etc.* He added that it is costing him $400 a month to keep the Tv wire in the Pilgrim Theater, Boston, whether it is used or not.

National Theaters (West Coast) has explored this idea and estimates that it would cost $3,750,000 to connect 52 of its theaters, with all necessary broadcasting and production layouts.

Requisite Transmission Facilities

Transmission facilities are a major problem. A. T. & T. is not equipped at present to extend its service for the prsent type of theater Tv, but it is expanding its facilities rapidly. Microwave relay is favored over coaxial cable to handle several groups of wavelengths more readily. The addition of new cities to Tv theater connections will require local terminal exchange facilities, and for these A. T. & T. wants $28,000 for each of these, *provided* there is definite assurance of future business.

Film exhibitors continued to view with great concern the dogged fight being waged by proponents of the pay-as-you-watch system of home Tv. Nor are Phonevision and Skiatron the only entries in this contest: Paramount is one of the most avid supporters of coin-in-the-box Tv, while RCA announced two months ago that it had perfected such a system and was set to go whenever the others were—FCC approval being requisite, of course.

Manufacturers of home Tv sets scanned all this theater Tv activity with a jaundiced eye, moving quickly to recapture major sports events and other attractions through the appointment of a committee to study methods for attaining this objective. Report has it that a voluntary payment based on set sales will be made by all manufacturers to finance a huge war chest to fight the theater Tv'ers. (The RTMA denies this.)

The Legislative-Legal Front

The most explosive development of the month was on the legislative-legal front. Many thousands who believe that they have a "vested right" to see *for free* in the home all major sports and other attractions (the claim being that this was implicit in the Tv set sale) deluged local, state and national authorities with complaints that theater Tv, pro and college football management, baseball clubs, *etc.*, were depriving them of their "rights" when they restricted broadcasts.

Legislators on all three levels, their ears acutely attuned to the great publicity possibilities inherent in the situation no less than in the imminence of the 1952 elections, promptly got busy. All sorts of "corrective" actions were suggested, ranging from the imposition of a special tax on such showings to prodding the Dept. of Justice to bring an anti-trust suit on a monopoly charge.

Evidently Justice was impressed, or the politico's wishes prevailed, because an anti-trust suit was filed against the National Football League in an attempt to break up restrictions on the broadcasting, radio and Tv, of the games. The Dept. of Justice said that the action was not aimed at theater Tv, but added "If we win here in our strongest suit, and if the shoe fits anywhere else, they will have to wear it."

Newspapers Cold to Theater Tv

Meanwhile, it appeared that a large group of newspapers, and particularly those who have radio and Tv station holdings, were giving theater-Tv showings the brushoff publicity-wise .In several cities where the Robinson-Turpin fight was piped nito theaters, the sports pages of the newspapers gave not an advance line to the fight itself, much less to the fact that it could be seen at a local theater.

Thus, the muddled Tv picture at this writing. One thing is certain, however: all these happenings will breed such confusion of thought in the mind of Mr. Exhibitor that he will be very reluctant to lay $25,000 and more on the line for something that might not pay off.

Tv: Time for Reappraisal

The appended penetrating commentary on Tv was penned by one of the best-informed men in show business—Abel Green, editor of Variety*—and is reproduced here by permission of that publication, the "bible" of show business.*

IN A relatively short period TV has started to pall. Video fans air the same gripes about the mediocre programs after two years as they did about pictures after over a quarter-of-a-century. Films are marking a box-office comeback; Tv is standing still, if not retrogressing.

Video is in for some serious soul-searching and self-examination. The sooner the better. Too many programs are NSG. Audience reaction is lethargic or negative—certainly not as enthusiastic as in the first flush of Tv.

The Show's the Thing

Since the show's the thing, neither a microwave-coaxial nor color will gild a wilting lily. If you've got the attraction, you can put it in Siberia and they'll seek it out; if it's a medley of mediocrity, it can stand smack on Times Square and catch only the breeze of customers passing by.

Showmen don't need any expositions on what's happening with Tv as of the moment—or, rather, what is not happening. Formulas are the same, be they the high-powered comedic programs or the relatively penurious panels.

Unfortunately for the medium, the impact is so socko that the audiences soon tire after absorbing so much. In some instances the viewers have literally become contemptuous through familiarity with the program content unreeled week after week. The eye absorbs so much and so fast that the reservoir of fresh material becomes an almost physical and creative impossibility.

Radio was different—the imagination through the appeal of only one faculty, the aural, maintained greater interest over a longer period of time. Tv is a combination of the aural and the visual, and both faculties reject after a short spell what they first eagerly accepted.

Ratings No Longer Valid

Ratings are no longer a criterion. They only indicate that the number of viewers is the same because of the constantly replenishing new set-owners. It also means that sets in use are *not* the same, because the vet video fan has gone back to pix or gone out of the house for other entertainment. Ratings certainly don't tell of the many tune-outs on programs of late—and this goes for the biggest shows.

It's a challenge therefore, to the new medium's showmanship if Tv is to maintain its potency. It certainly indicates a necessity to dare to do the different; to explore new avenues and channel new talents for that iconoscope. There's a limit to comedians, variety shows, ballets, whodunits, panels, quizzes, parades. That limit is being reached. In some instances it's near the deadline.

Sponsors happy over trademark identification won't be so happy if it gets around that the lookers ain't looking. Tv, like radio, is still a medicine show with electronics. If they're not selling nostrums, the pitch is for something else, but whatever the sugar-coating it is pertinent that the lure had better be potent or they won't stick around for the commercial.

At least the picture business sells nothing but entertainment. If the film's value isn't there, they don't lay it on the line—as has happened until Hollywood buckled-down-Winsocki and started turning out the recent crop of quality celluloid. Tv is in the same hazardous position, which is the more dire in portent considering the relative infancy of the medium.

The Movies' 'Lost Generation'

Statistics *per se* have become the bane of our age, particularly in merchandising, mainly because they involve the use of figures *in the mass* which, broken down anyway the statistician wishes (always with the client in mind) never benefit by a look-see into the motivating factors in the *individual* mind. The motion picture industry has suffered acutely from this statistical t-error.

For what it may be worth, we append here the latest statistical roundup relative to box-office anemia as supplied by *Business Week*, organ of and for *big* business.

Age Group as Moviegoers

The ages between which people attend movies most frequently are 19 and 25. The war drew off a hefty part of this group. Toward the end of the war, vast numbers of people in this group got married immediately. Soon most had children. For the price of admission plus the price of a baby-sitter, you could make a week's payment on a refrigerator—or, later, a Tv set.

In 1945 there were 1.6 million marriages. In 1946 there were almost half again as many—2.2 million. And within the two years between 1945 and 1947, the birth rate had sky-rocketed from 2.8 million to 3.8 million.

Also, about 70 of all marriages take place between the ages of 18 and 24. And the average marriage age in the U. S. is 23 for men and 20 for women. In other words, the sociological phenomenon of widespread marriage right after the war left a real boxoffice vacuum. (One significant exception: the drive-in theater, where parents could skip paying a baby-sitter by throwing the kids in the back of the car.)

New Crop of Movie Fans

Both the birth rate and marriages are still running at a good clip—though not as high as immediately after the war. But now every day more and more kids are getting to the moviegoing age. These are children born in the 30's.

Indirectly, Tv may actually be contributing to moviegoing now. The new generation has grown up enough by now to be interested in courting. Tv keeps the family in the living room, which rules that out for courting. So the movies get the youngsters' trade.

Brokers See Steady B. O. Upbeat

The motion picture box-office upturn is more likely to gain momentum than not, according to a research department bulletin of Paine, Webber, Jackson & Curtis, N. Y. stock brokers. Survey points out that a more normal share of the consumer dollar should be available from now on, with hard goods competition beyond its peak, and installment purchases resulting from the post-Korean scramble for goods due to be liquidated by next Spring.

As to Tv competition, the bulletin points out: "The novelty seems to be wearing off—and the talent voraciousness of Tv probably means an average level of program quality which can't compete with a really top-notch motion picture. When the public gets bored, America's gregarious urge manifests itself—and more often than not this means 'going to the movies.'"

Bulletin remainds that notwithstanding the over six million more Tv sets in use today than a year ago, the trend of motion picture attendance turned upward in the Summer months, with the upturn continued through September, despite the return of top Tv shows to the air.

Hoff New Prexy of TESMA

The Theatre Equipment & Supply Manufacturers Assoc., at its recent annual convention in Hollywood, elected J. R. Hoff (Ballantyne) to succeed Oscar Neu (Neumade Products) as president. Also elected were Roy Boomer, sec.-treas., and as directors Harry Strong (Strong arclamps); W. C. DeVry (DeVry Corp.); W. B. Gedris (seating); Larry Davee (Century Projectors); Jack O'Brien (RCA); V. J. Nolan (National Carbon); E. W. Wagner (signs); Fred Matthews (Motiograph, Inc.); Clarence Ashcraft (Ashcraft arclamps); and Ben Adler (signs).

Ozone Biz Up 35% Since Jan. 1

Drive-in business is up 35% since the first of the year, running well ahead of regular four-wall houses which generally have shown an increase up to 10% for the similar period, according to a spot survey of domestic revenue figures of the major film companies.

Ozoners, therefore, would appear to be relatively safe from the Tv "bogeyman" at this time. More important, however, according to one distribution chief, the 35% figure indicates that drive-in theaters are either bringing back the "lost audience" to the movie-going habit, or are possibly serving as the lure for patrons who have never attended a movie before.

Sub-Standard Equipment—40%

Upwards of 40% of film theaters today are not maintaining proper equipment standards, according to the report of a special committee at the recent TOA convention. Time for correcting this situation is now, the report stated, because it appears that material shortages will get worse before they get better.

All essential equipment units are now available, but the situation may change radically within the next several months. Stress was laid on the necessity for pushing the carbon arc copper drippings program to the limit, so that not a single pound of the metal is overlooked.

Tax Take Shows B. O. Advance

Official statistical backing of claims for increased box-office returns in the second half of the year was supplied in the Internal Revenue Bureau report

Technology on the March

• New cooling technique for electric transformers may reduce weight by one-third, step up ppower handling ability, reports Westinghouse. Nozzle sprays liquid fluorocarbon on hot core and coils, liquid is vaporized and vapors condense on cooling surfaces of transformer tank.

• Lightweight storage battery that will start a car at 65 degrees below zero, developed at the Univ. of Michigan Research Institute, is expected to have wide application. Lead plating of materials ordinarily corroded by sulphuric acid makes replacement of much lead now used in batteries possible.

• High-voltage electron-beam sterilization on a production-line basis is economically practical, states High-Voltage Engineering Corp., Cambridge 38, Mass. Process uses Van de Graaff accelerator, is said to be safe, dependable, non-injurious to food and other products.

• New aviation gasoline additive reduces spark plug fouling, reports Shell Oil Co. Failure of spark plugs comes from electrically-conductive deposits which short-circuit it; new ingredient reduces fouling by changing nature of deposit so that it does not become conductive.

• Ball bearing-type microscope, developed by Bausch and Lomb, is said to offer easier, more critical focusing and longer instrument life. It features ball bearings and rollers within focusing mechanism and pressure-loaded ball bearings around rim of nosepiece.

• Improved transistor, tiny amplifier that occupies 1/400 as much space as a vacuum tube and can do the same job, announced by Bell Telephone Laboratories, New type has uniform performance, will get trial use next year.

• "Does all research pay off? I wish it did," said C. H. Greenwalt, DuPont president. He estimates that *one of* 20 projects yield a profit.

• About 150,000 technical reports have been collected by the Office of Technical Services, U. S. Dept. of Commerce, Washington 25. Prepared lists of reports on some 50 major fields of interests are available, most of them free of charge. OTS describes collection as so great in scope that it remains largely unexploited, invites written inquiries.

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of admissions tax collections for August, reflecting business done in July.

IBR reported that general admissions tax collections in the month were $34,142,531, compared with $31,606,356 for the same 1950 period. Achievement marked the first month since February—January business that tax collections were ahead of the comparable month of last year. It is estimated that 75% of admissions tax collections are from motion picture theaters.

Printing Color Tv Plates?

In a New York print shop experiments have been conducted for RCA, looking to mass production of color-tube plates. Patterns of small dots were printed on glass sheets, using rubber plates, employing three types of phosphor pigments, similar to printing three-color pictures. Each set of dots was not to coincide with any of the other sets of dots.

These experiments were successful, from the printing standpoint, and a number of such printed-phosphor glass plates were made. Other experiments were then carried on to do similar printing via the silk-screen process. The phosphor pigments used in printing were supplied by RCA. In daylight, all the material was white to the naked eye, but was said to glow blue, red and green, according to its type.

Are There Four Retinal Colors?

The textbooks have long agreed that the human eye can detect only three colors—red, green, and violet; that we have no retinal receptors sensitive to yellow. But now, before the American Association for the Advancement of Science, Dr. L. M. Hurvich of the Eastman Kodak color-control department, Rochester, N. Y., reports experiments indicating that impinging "pure red" on one retina and "pure green" on the other, combine to produce white, while "pure yellow" radiation gave a yellow sensation.

He testifies that there is no binocular fusion which creates yellow out of pure green and pure red, but that the eye can see yellow alone, indicating the presence of yellow receptors.

A.S.A. Acoustical Dictionary

The recording and reproducing industry now has an authoritative dictionary of terms compiled by experts in the acoustical field. This document—the latest edition of the A.S.A. Terminology (Z24.1—1951)—has just been published by American Standards Assoc., 70 East 45th Street, New York 17, N. Y. (Price: $1.50).

For the first time, more than 150 terms used in connection with mechanical, photographic, and magnetic recording are printed and defined in one document. Various types of instruments used and the various kinds of noises produced are defined. Until recently most of the language used in con-

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nection with magnetic recording was slang. Now most of the terms are correlated and presented with standard definitions agreed upon by experts.

Inclusive Range of Topics

Definitions for sound recording and reproducing systems; instantaneous recording; frequency response equalization; mixer; magnetic recording; magnetic powder-impregnated tape; magnetic wire; magnetic recording reproducer; erasing head; double pole-piece magnetic head; magnetic biasing; light modulator; galvanometer recorder; multiple sound track; variable-density track; opacity; photographic transmission density; H and D curve; noise reproduction; mechanical phonograph recorder and many others are included in the standard.

This edition also contains a table giving the conversion rate of present acoustical units into the meter-kilogram-second system (mks units) now being used more and more by physicists and electrical engineers. Also, there are sections on hearing and speech, sound transmission and propagation, transmission systems and components; ultrasonics, music, shock and vibration, underwater sound, general acoustical apparatus, and architectural and general acoustical terms.

Extreme Temperature Range Film

How to make photographic film that will not get brittle and crack in Arctic cold and will also be good in tropic heat is indicated in a signal Corps research report, now available, the U. S. Dept. of Commerce has announced. To get film which would stand up in the hottest Tropic and coldest Arctic regions, the Signal Corps directed Armour Research Foundation to develop photographic film bases which would have "good dimensional stability, optical clarity, low moisture absorption, constancy of composition, good aging qualities and ease of fabrication" over the entire temperature range from —65°F. to 140°F.

PHOTOGRAPHIC OPTICS

(*Continued from page 19*)

focal length of a lens is defined as the distance from the second nodal point to the focal point in parallel light, and that this length is seldom equal to the distance from the rear lens vertex to the focal point. The back focus is, in

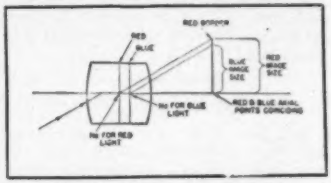

FIG. 23. Lateral chromatism, II.

fact, what we have achromatised as the first step in color-correcting our lens.

We have not assured the same focal length in the two colors, blue and red; in point of fact, it will usually differ with color. Just what effect does this have on the imagery from our lens?

Size of the Image

We saw previously that the size of an image is dependent on two factors: the object distance, and the focal length of the lens. It is clear, then, that if our lens possesses focal lengths different in different colors, it will produce images of varying sizes in those colors. It is for this reason that the second chromatic aberration is called *chromatic difference of magnification*, or lateral color, since a lens afflicted with this aberration will produce a larger red (blue) image than blue (red); or in white light, points in the field will be pulled into rainbows (Fig. 23).

Obviously, this aberration is independent of longitudinal color, since the

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latter is concerned only with color correction of the back focus, whereas this is concerned with a different quantity, the equivalent focal length. It is further readily appreciated that for the best imagery a lens system must be corrected for both aberrations which involves two different methods.

Common Color Images

In the case of chromatic difference of focal points, we were able to effect correction very simply—by employing a negative lens whose characteristics cancel the dispersion of the positive lens, thus reuniting the dispersed colors. With the more troublesome lateral color, we are forced to use a trick illustrated in symmetrical lenses: using systems of opposing tendencies. Some system will yield a spectrum with the red higher than the blue; while others will reverse the order. The proper combination of these two types will yield a system giving a common size to the red and blue images.

Of course, each of the five aberrations considered herein has its own chromatic variant in the sense that its value in the different colors will vary. However, that variation is of a smaller magnitude compared with the two pure color aberrations we have been considering, and is of little interest to us here.

Summary of Aberrations

We have now seen that there are seven different types of defects which plague the lens designer, and which he has either to remove or to balance one against another in the design of a satisfactory photographic lens. They fall naturally into three different classes:

Those affecting the sharpness of images in monochromatic light: spherical aberration on the axis, and coma and astigmatism off axis; those affecting the position of the sharp image points, and distortion, effecting lateral position on field magnification; and third, the two chromatic aberrations: axial, affecting the focal positions in different colors, and lateral, influencing the magnifications in different colors.

It is often said that because of the increasing use of color photography lenses will have to better corrected in the future. There is but a shell of truth in this statement, for it cannot be denied that a simple positive lens designed for use in conjunction with unsensitized, or orthochromatic, film cannot yield satisfactory images in color where automatically one is critical. The assertion is true to just that extent.

It should be clear from the preceding discussion that color photography introduces nothing new in the way of performance demands on lenses, the only difference being that with color film the aberrations can be seen as color, and not

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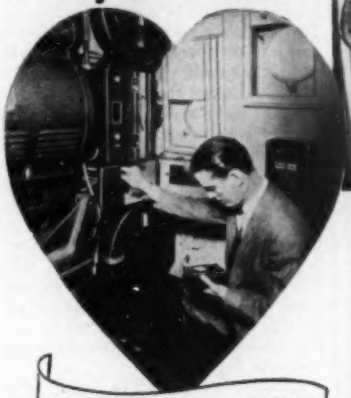

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as a blob or blur casually ascribable to some other cause. The best lenses have always been "fully color corrected." However, a continual improvement is being effected in lenses for all the aberrations, and our children's lenses inevitably will be better than ours.

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'SHOWBOAT' CAMERAWORK

(*Continued from page* 15)

museum. More than 300 feet in length, it was just the prop we needed; so arrangements were made with the owners to use it for the picture.

The most important shot for which it was required was a scene—a long shot—showing it moving up the river at dusk, its cabin lights ablaze and passengers promenading its decks. Now this shot easily could have been done in miniature, but needless to say not with the same authenticity. Inasmuch as the cost would have been about the same, we decided to make the shot the way we did—using the real boat on the Mississippi.

Ingenious Lighting Set-up

A 300-amp generator was installed temporarily on the craft to supply power for the lamps that were to furnish illumination behind the windows. The boat's steam plant long ago having been sold for junk, it was necessary to provide temporary motive power. Two tugboats were made fast to the packet on the side opposite that which was to face the camera, to move it upstream while we made the shot.

Hundreds of photoflood lamps were used to supply light back of the windows. Because it was necessary to secure every available foot-candle of light the lamps would give, in order to make the boat's interior appear brilliantly lighted, the lamps were mounted directly behind tracing cloth panels tacked over the boat's open windows. The lamps were placed so that the filament of each was directed as near as possible at the lens on the camera (which was set up on another boat some distance away), and with the filament at the same height as the camera lens. Only by doing this was it possible to secure the maximum volume of illumination from each lamp.

To obtain the desired pictorial result, Rosher calculated that the scene would have to be shot at precisely a certain time after sundown. It couldn't be ten minutes too soon or too late. On the previous evening he had made an exposure test at twilight to determine the correct balance between the artificial light, coming from the boat, and the waning daylight.

Ten Minutes—a Lighting Masterpiece

On the following evening, when the scene was to be filmed, there was no time for rehearsals. The reason for this was that the artificial light coming from the windows of the boat had to be the dominant light in the scene, yet exposure had to be ample to give a clear outline of the boat in the dusk, and consequently a rich print. The whole operation, once ready to shoot, required about ten minutes time—ten tense, anxious moments for all of us. No process shot could have equalled the result. It is truly a masterpiece of color photography.

In the beginning, we had considered shooting the showboat exteriors on location on the Mississippi. However, after long and careful search, which took us from New Orleans to Cincinnati, two things became apparent: there was not a boat on the entire river which met all our requirements and, most important, the Mississippi river currents were such that operating camera and lights from other craft on the river would have been almost impossible. So we decided to have the showboat built on the studio's back lot.

The finished craft, named the "Cotton Blossom," is the largest movable prop ever built on a Hollywood motion picture lot. It floats lazily on the lake in MGM's lot number three, awaiting future assignments.

Whereas shooting scenes on a boat on the Mississippi would have entailed lighting problems—and the inability in

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many cases to maintain directional lighting continuity—with the studio built boat we were able to keep this factor under absolute control, simply by moving the boat and following the sun around as necessary.

'Weathering' the Showboat

When construction of the boat was completed and the painters had finished recorating it, the result was a sparkling new boat just off the boatmaker's ways, instead of a weatherbeaten Mississippi river boat. Studio painters then applied "weathering" to its entire exterior and the photographic result is everything that could be desired.

This is but one example of the myriad of details which Rosher constantly surveyed from the photographic viewpoint, directing such changes or improvements as were necessary to achieve the photographic excellence for the production that was our constant aim.

While the photography of the vast number of exteriors involved the most interesting experiences, the interiors demanded no less attention from the camera viewpoint in planning and lighting. Perhaps it was because we had held many pre-production huddles with the art director on wardrobes and set decorations that camera problems on the interior sets were greatly minimized.

Subject-Background Separation

Care had to be taken against having costumes too somber in tone, yet not garish, either—so they did not merge and become lost in the background. There must be good color separation always between subjects and background to get the most pleasing effect in color cinematography. In this respect, we utilized a lighting trick worth noting. After the key light had been established, an additional light source was directed on other objects or on the background itself in order to gain the desired compositional effect. This is something that rarely can be determined by meters—one has to have it in him, intuitively.

Photography, I believe, has now become so popular, audiences have come to expect better camera work on the screen. That is why we made it a point to be so meticulous with the photography of "Showboat." Having educated the public to expect the best in photography, we now have to keep ahead of them. I think we can say in all honesty that, because of all this, we are constantly improving the tastes of the people of the world, influencing their dress, makeup, their manners and also the graphic arts.

Being ardently interested in photography has brought me in closer understanding with the director of photography's problems, and from this has stemmed an invariable practice of consulting at great length with him during the course of preparing a picture for production.

A 'Director's Cameraman'

I like to think of "Showboat" as an example of the point I have often made that when a director and his cameraman both speak and understand the same language—the language of photography—superior motion pictures invariably result.

We often hear applied the appellation "cameraman's director"—meaning a director who works harmoniously with a cinematographer. Conversely, I think Charles Rosher is the epitome of the director's cameraman. His tremendous experience and wealth of photographic knowledge, his personal "bag-of-tricks," and his ceaseless enthusiasm and dogged perfectionism are qualities which contributed to the standout photographic job of "Showboat."

BRITAIN'S TELEKINEMA

(*Continued from page* 13)

its associated amplifier cubicle, the unit standing a few feet behind the associated projector.

Electro-Acoustic System

The electro-acoustic system is fairly conventional, with emphasis on wide frequency range and low amplitude distortion throughout the whole system. Any magnetic reproducer pick-up head has an output which over the major part of the useful frequency range is proportional to frequency, thus a large amount of frequency compensation is required to obtain a flat overall frequency char-

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acteristic. The main amplifiers have a power output of 20 watts per channel.

The five amplifiers (four channels plus one spare), the gain controls and control push buttons are mounted in the main amplifier cabinet, provision being made for a "switch interchange" between the center channel amplifier and the spare unit. Failure of any of the other three amplifiers requires the interchange of wiring plugs, a process that is greatly simplified by the method of mounting and the use of only two plugs for all connections on each of the amplifiers.

The screen loudspeaker system is fairly conventional, each of the three channels using a standard combination of two-unit e-f horns and two-unit h-f horns with a changeover frequency of 500 c.p.s.

The screen speakers are used for all sound film, monaural or stereophonic, the Tv sound, the interval music, and if the original ideas had matured, for 16-mm sound also. To reduce the load on the projection room staff, selection of the speaker system appropriate to the picture is made by a switching system incorporating non-linear resistors. Thus, on a changeover the projectionist on the outgoing machine turns his gain control to zero, gives an aural or visual signal to the man of the incoming machine, who has only to depress his "sound" push button to select the appropriate speakers.

These "sound" buttons are located on each machine in close proximity to the gain controls. A loudspeaker selector unit containing the changeover control circuits and the deaf-aid amplifiers is located adjacent to the right-hand machine. It carries indicator lights of different colors which show which speaker system is in operation.

Four monitor speakers of conventional design reproduce sound from the four output channels; those corresponding to the three sets of screen speakers being mounted on the front wall of the box, while the fourth, monitoring the auditorium sound effects, is mounted on the rear wall of the box.

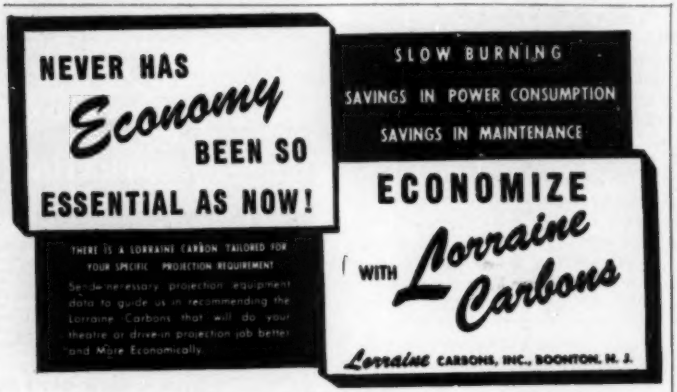
Control System

When projecting stereoscopic films or using the magnetic sound heads it is essential to operate two or more machines in exact synchronism from standstill. Normal synchronous drives are insufficiently accurate to maintain such exact correspondence even though the films are correctly framed when threaded, but the application of a Selsyn interlock system makes it possible to obtain the synchronization necessary in a relatively simple manner.

Selsyns are similar to A.C. induction motors, with wound rotors and stators, the stator winding being energized from the mains, while the rotors of the two Selsyns to be interlocked are connected in parallel. The stator windings induce mains-frequency voltages into the rotor windings, and the two rotors move relatively until the voltages induced in the two rotors balance each other with no current flowing in the rotor circuit. If one rotor is turned mechanically, the rotor of the second machine will move to keep the same relative position, and this occurs even with the rotor turning at 1440 r.p.m.

The Festival requirements are met by mounting a Selsyn motor adjacent to each driving motor, the two motors being coupled by a roller chain drive. Correct phasing at standstill is achieved by supplying single-phase excitation to the stators before film threading commences, and on depressing the "start" push-button all interlocked units will run up in exact synchronism.

As the number of machines in operation depends on the program being pre-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sented, all the control switches are grouped together in a Selsyn selector panel, thus permitting the projectionist to verify at a glance the combination selected for operation.

Changeover Devices

The light and sound changeover devices on the standard equipment are electrically operated, depression of the "changeover" button on the incoming machine opening the "incoming" shutter and closing the "outgoing" shutter. This facility is retained in the Festival equipment, but the arrangement has to be modified when projecting stereoscopic films, as both machine changeover shutters must open or close together. Appropriate arrangements ensure that switching of the equipment to the "stereoscopic" position automatically closes both machine shutters. During stereoscopic operation the normal changeover push-button operates both shutters in phase, i.e. they open together.

This completes a rather brief description of the Festival equipment, but it is probably true to say that it represents an advanced view of the projection room of the future, embodying some of the equipment that will undoubtedly prove essential if the kinema is to retain its present pre-eminent position.

LENTICULAR COLOR FILM

(*Continued from page* 9)

achieved by use of a lens of the correct E.F.

Also, the common practice of simultaneously shooting long shots, medium shots, and closeups by a battery of cameras operating in a restricted area is made possible only by the use of camera lenses having different focal lengths. This technique minimizes the number of necessary retakes, thus saving hundreds of thousands of dollars a year.

Process Projection Impractical

Then, too, out-of-focus backgrounds and foreground objects are frequently desirable from an artistic standpoint. Lenticular color therefore denies the cinematographer much of the flexibility of his art.

8. Great economy is also effected by the use of background projection in studio sets. Lenticular color, because of poor illumination efficiency, slightly fuzzy image definition, and unsatisfactory color-distribution characteristics when projected through translucent background screens, would render the valuable tool of process projection impractical. All of these are matters of tremendous importance, not a single one of which may safely be overlooked.

Filter Transmission Data

Tremendous loss of screen illumination is a fatal defect of all additive color-projection processes.

Three primary-hued filter stripe must be placed side by side over the projection lens in the proper optical plane, as previously mentioned. (This plane would probably intersect the lens barrel somewhere near the middle of its length, the filters thus being inside of the lens barrel.)

Each of these filters, if possessing

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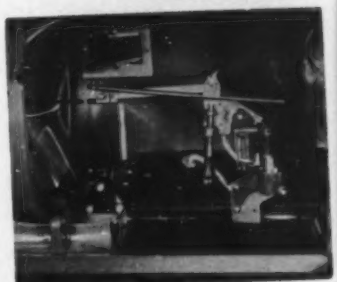

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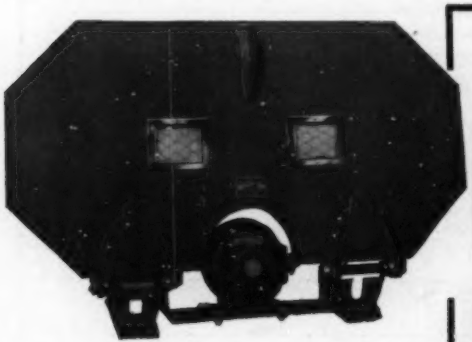

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perfect transmission characteristics (which existing filters most assuredly do not), would transmit 1/3 of the light falling upon it, as reckoned on the basis *not* of actual "luminosity" but of color balance. Thus 2/3 of the total projection light is absorbed by the filters and converted into heat, reducing screen illumination to 33 1/3% of the illumination obtained without color filters. But as things actually are, the most efficient existing filters have approximately the following transmission efficiencies:

Vermilion	80%
Emeraude	40
Indigo	60

Because each filter represents one-third, or 33 1/3%, of the total light (total color balance), use of these filters would result in 20% of standard screen illumination. (The V filter transmits 80 x 33 1/3%, or 26.66%, of 1/3 of the total light; the E filter 13.33%, and the I filter 20%, giving an over-all average of 20%.)

Filter Balance Requisite

However, this filter combination *will not work!*

It is mandatory that the three filters be *balanced* so that *equivalent proportions* of V, E and I light reach the screen (to give pure white light) when the projector is run without film. The transmission efficiency of *each* filter must be the *same* as the transmission efficiency of the *least* efficient filter! (In actual practice the emeraude filter happens to be the least efficient.) So, instead of the figures given in the foregoing tabulation, we must use the following:

Vermilion	40%
Emeraude	40
Indigo	40

This reduction in the light transmissions of the V and I filters will enable more satisfactory color reproduction to be obtained, because better V and I dyes can be used, but the screen illumination will be only about 14% of that obtainable with Technicolor and other non-lenticulated standard prints!

Enormous Light Increase

The lenticulated color-film process, therefore, demands projection lamps about 7¾ times more powerful than present-day lamps.

Can projector arclamps nearly 8 times more powerful than those now in use be manufactured on a practical commercial basis? *Probably not.*

If such powerful lamps *could* be made, would exhibitors be willing to pay increased carbon and power costs merely to maintain levels of screen illumination which obtain *now* in theatres?

Is any present film capable of withstanding the terrific blast from lamps so powerful?

Would the theatre-going public accept a color process which is decidedly inferior to the least desirable color process in use today?

The answer to the three foregoing questions must be an emphatic "No".

This, then, is the sad, sad story of lenticulated color-film processes. The disadvantages of this process are obvious to everyone except a coterie of short-sighted producers who have the strange notion that color footage should cost not a penny more than black-and-white.

Existing Processes Superior

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Of INTERNATIONAL PROJECTIONIST, published monthly at New York, N. Y., for October 1, 1951.

1. The names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher: INTERNATIONAL PROJECTIONIST PUBLISHING CO., INC., 19 West 44 St., New York 18, N. Y.

Editor: HENRY B. SELLWOOD, 19 West 44 St., New York 18, N. Y.

Managing Editor: R. A. ENTRACHT, 19 West 44 St., New York 18, N. Y.

Business Manager: R. A. ENTRACHT, 19 West 44 St., New York 18, N. Y.

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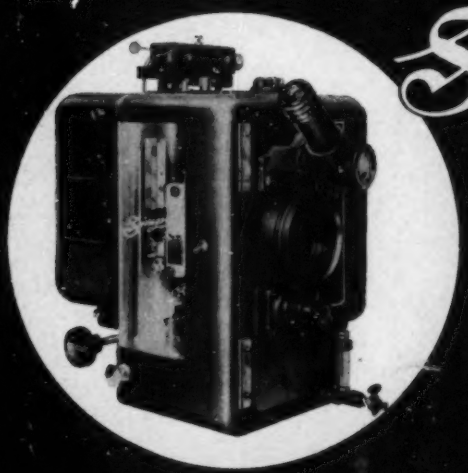

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